POWER

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Public Sentiment

THERE are a lot of things that are not as the majority of the people would like to have them; and most of them could be made right or at least improved by human effort intelligently applied.

It is natural, in cases where privilege has been usurped, where selfish interest has profited at the general expense, when natural calamity or economic distress befalls to turn to the government for justice and relief.

But how is a government "by the people" going to know what to do about it? How is the clamor of the propagandist, the extremist, the scrambler for advantage, the iconoclast, the alarmed conservative, the vociferous complainant and reformer, the panacea peddler to be concerted into a concise expression of the will of the majority?

And if it could, what assurance would there be that it would be the wisest and best thing to do? The majority is not always right. In fact there is a large measure of justification for the assertion that has been made that the majority is always wrong.

Nevertheless, there is much virtue in enlightened public sentiment. No measure adopted by any government can be effectively enforced if it violates the sense of right and justice of a large proportion of the people. Under no system, political or social-economical, can practices be forever continued which exploit the masses, expropriate commercial resources or profit those in positions of influence at the cost of the many.

Aroused public sympathy is the best assurance of relief in time of affliction, alert public sensibility to immorality and crime is the best deterrent to wrong doing, and aggressive public resentment one of the most effective punishments for breaches of trust.

If one knew that through committing crime or taking unfair advantage he was incurring the actively manifested disdain and obloquy of his fellowmen and business, political and social ostracism there would be less temptation to do it.

F. R. Low

EDITORIALS

Lessons From Chicago

NOW THAT the Fifth Midwest Power Conference and the Fourth National Fuels Meeting have passed into history it is in order to evaluate, if posisble, their contribution to engineering thought and progress. That this joint meeting was a good one, better in certain respects than previous meetings of either body, practically all who attended will agree. But that is not enough. If the lessons of this meeting are to be of assistance to those who will plan future conferences, one must delve deeper to uncover the factors that have made its success so generally felt.

In the first place the number of papers was kept down and their quality was, in general, of a high order. The diversity in subjects treated was broad and showed timely selection. And, finally, there were no simultaneous sessions within either the Power Conference or the Fuels Meeting programs. Such overlapping of the two as was unavoidable was kept to a minimum by careful planning. On one morning only were there simultaneous sessions that seemed to hold interest for the same people. It was unfortunate that the Power Conference papers were not preprinted, as this undoubtedly would have added still greater value to the discussion.

Those who arranged the programs, as well as the authors and those who engaged in the discussion, are to be congratulated.

Construction Problems With High-Pressure Turbines

THE CONSTRUCTION of turbines for high steam pressures and temperatures has presented new problems to both builder and operator. American units have generally employed a speed of 3,600 r.p.m., although higher speeds have been used abroad.

The design of the casing is difficult. It is made of thick forged steel to withstand the high pressures. Some European units have been forged solid, with diaphragms and spindle fed into a conical bore from one end. The split casing has advantages, but this construction presents many problems. What is the best method of holding the two flanges together when high temperatures are used? Are bolts entirely satisfactory for this purpose? There are also severe stresses set up in the metal itself due to its thickness when heated up or cooled quickly. Can these be minimized by jacketing with heated air?

Steel under stress at high temperature and pressure tends to creep. The limitation imposed by creep appears to be a factor that must be considered in fixing a commercial upper temperature to which steam may be superheated. At present this limit seems to be about 900 deg. F.

The design of steam glands may also be troublesome. It is sometimes difficult to keep these tight with high pressures and temperatures. The disposal of the gland leakage steam leads to difficulties. Turbine shafts are made small partly to reduce leakage, but this tends to increase deflection and may lead to vibration. The final design is always a compromise.

A number of new problems are thus involved in the design and construction of high-pressure turbines. Units built to date have performed satisfactorily and creditable efficiencies have been obtained. However, higher temperatures and increased sizes may require modifications in design, and the problems mentioned will continue to tax the ingenuity of the designing engineers.

Atmospheric Pollution

THERE is no doubt of the power engineer's quickening interest in the elimination of atmospheric pollution, of which the smoke, fly ash and sulphur nuisances are important elements.

These factors have definitely become a part of the mechanical designer's and power plant builder's problem, and they are fully aware of it. If proof of this were needed, the recent joint meeting in Chicago of the Fuels Division of the A.S.M.E. and the Midwest Power Conference provides it.

Although the meeting ostensibly included but one session on fly ash, scarcely any of the other sessions failed

to make some mention of atmospheric pollution in one form or another, and to include a lively discussion of its bearing upon numerous details of present and future design.

In natural gas and oil advocates of these fuels see reasons for the growth of their businesses as the result of freedom from fly ash and cinder. The pulverized-fuel people are aware of the influence of the present state of thought upon their activities and are discussing corrective steps. Stoker manufacturers talk openly of the necessity for smokeless combustion and how to accomplish it.

Doctors tell of statistics and studies which point clearly to the deleterious effects from the insufficient supply of ultra-violet light which struggles through the murky atmosphere of some of our large cities. Smoke commissioners relate their problems in the promulgation of suitable legislation and the administration of existing smoke laws to secure clean atmosphere.

That all these and many more equally important phases of the subject were presented to earnest audiences representative of the leading engineering talent of the power production field is clear evidence that mechanical and power engineers accept the responsibility and intend to solve their portion of the problem of atmospheric pollution.

Under such circumstances there is no alternative to steady and gratifying improvement of existing conditions.

Niagara Protection Awaits Senate Action

PREVENTION of the destruction of Niagara Falls by erosion, the preservation of its scenic beauty and the utilization of its power possibilities have long been discussed in Canada and the United States. An international board of engineers was created by the two governments in 1926 to study and recommend how best to accomplish these purposes. This board, in presenting its report in 1928, recommended the building of remedial works above the Horseshoe Falls and that a temporary water diversion be made to test the effect of the proposed structures. In January, 1929, a convention was signed by representatives of the two governments providing for the construction of remedial works in the Niagara River above the Falls, closely following the recommendation of the engineering board.

This convention, to become effective, requires approval by the United States Senate. For the last two years it has remained in the Senate Committee on Foreign Relations, where effort is being made to make its approval contingent upon Canada's agreement to a deep waterway in the St. Lawrence.

To the extent that Niagara Falls has anything topographically to do with the St. Lawrence deep waterway, Canada has completed the work at a cost of over one hundred million dollars. The Welland Canal, which connects Lake Erie with Lake Ontario, has been deepened to twenty-seven feet, and locks have been constructed that will admit boats of thirty-foot draft, as generally proposed for the St. Lawrence deep waterway. In view of this it is difficult to understand by what logical process the United States Senate makes the approval of the Niagara treaty contingent upon the remaining portion of the project, which is three hundred miles away.

The Niagara treaty should be approved or rejected on its merits and not be made to serve political expediency. The treaty in its present form does not call for any permanent water diversion at Niagara Falls. It proposes the construction of remedial work in the river and temporary diversion to test the effect of the structures to be built in the river. The cost is less than two million dollars, which the power companies on the two sides of the river have agreed to assume. However, nothing can be done until the spirit moves the United States Senate. When will it act?

Sir Charles A. Parsons

BY THE recent death of Sir Charles A. Parsons the world lost an engineer whose steam turbine inventions exerted a great influence on the growth of this prime mover which has done much to advance industrial progress and human happiness. His outstanding achievement was the invention of pressure staging, which principle he applied in 1883 to the construction of the first successful reaction turbine, a six-horsepower double-flow unit now preserved in the Science Museum, London.

Sir Charles' vision, patient research and enthusiasm were responsible for the application of the turbine to ship propulsion. The first turbine-driven ship, "Turbinia," containing three units which developed a total of two thousand horsepower. She reached a maximum speed of thirty-three knots during her trials in 1894.

Sir Charles gave the impression of a great workman to whom work is not the means to an end but an end itself. Although his was a life of study and untiring industry, he retained to the end the enthusiasm of youth, together with a simple kindliness of manner and old world courtesy that endeared him to all his friends.

POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3 Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

Midwest Power Conference Presents Broad Program

Economies, plant investment, prime movers, high-temperature metals, welding, air conditioning, the dual supply of power and steam, boiler feed water and evaporator practice were some of the topics that made this meeting outstanding in the history of the conference

POWER WEEK in Chicago dated from Feb. 10 to 14. One of the three events contributing measurably to progress in the field was the Fifth Midwest Power Engineering Conference, with headquarters in the Stevens Hotel. For the fifth time the three-day joint effort of nine participating societies resulted in a most successful meeting. Total attendance at the Power Conference and the National Fuels Meeting approximated 1,000. The programs for the two meetings had been co-ordinated for a minimum of conflict between sessions. Beginning Tuesday noon, the Conference ended Thursday, whereas the Fuels Meeting started a day later and carried over into Friday.

At six technical sessions and two luncheon meetings some twenty papers were presented at the conference to cover various phases of the power field of timely interest. As many of the papers were of excellent quality, it was unfortunate that funds were not available to provide preprinted copies. These papers, for the most part, were of broad, general character, giving the status of present-day developments.

Some of the topics considered were plant investment and operating cost, advances in electrical distribution, welding in the power plant, high-voltage direct-current transmission, the dual supply of power and steam, high-temperature metals, and the pumping of oil, gas and gasoline. A full session was devoted to refrigeration and ventilation, covering air conditioning and the future prospects of central station refrigeration. Prime movers also were assigned a full session, in which the steam turbine, the reciprocating engine, the internal combustion engine, and the propeller-type water turbine each were given their innings. Under feed-water problems, pre-treatment, evaporator practice and design, and concentration control were discussed. Aimed to interest the civil engineer primarily, the concluding session related geology with power reservoir and damsites, and disclosed features of the proposed Chicago subway.

The big social feature of the conference was an unusual banquet and dance in which entertainment predominated far beyond any previous conference effort. Growth of power from cave days to the present was depicted in a series of tableaux presented between courses of the dinner, with a running story set to music to link them together and lead up to the topic of the evening, "The Electron-Midget Ruler of the Universe," by O. H. Caldwell, editor of *Electronics* and formerly Federal Radio Commissioner for the Eastern District. Spectacular demonstrations of electronic application, including selections on the "Theremin," eventually gave way to dancing. The attendance exceeded 1,100.

President H. W. Fuller officially opened the conference at a luncheon Tuesday noon. A word of greeting from George W. Rosseter, vice-president of the Chicago Association of Commerce, and Major L. R. Lohr, manager of Chicago's international exposition, "The Century of Progress," launched into an address on "Power in a Century of Progress."

Until the latter part of the eighteenth and the first of the nineteenth, he said, prime movers had been practically limited to those primitive machines operated by men or animals, or by the wind or running water. The small amount of power developed was restricted in its use to a radius of a few feet from the source. The horizontal and the undershot waterwheels were the only ones in common use until the partial perfection of the water turbine by Fourneyron in 1832.

Some of the phenomena of steam and the expansive effect of heat on air were apparently vaguely understood by Hero of Alexandria, but the sole use of this knowledge was confined for many years to the construction of toys or of devices designed to mystify.

Worcester in 1603, Savery in 1698 and Newcomen in 1705 applied the principles discovered by their predecessors, and the so-called atmospheric engine of Newcomen was the final result.

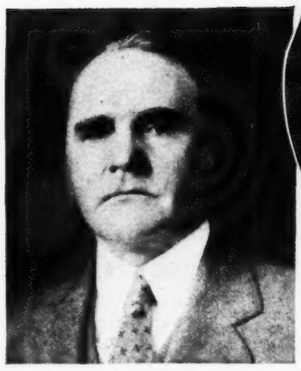
Although the idea of the compound engine had occured to Hornblower in 1781, it remained for Watt, in the latter part of the eighteenth century, to develop the steam engine into the forerunner of modern reciprocating machines.

The story of the development of power in the past century cannot well be condensed in so brief a statement, but in 1933, Chicago anticipates that it will be able to present this story better than an exhaustively written treatise on the subject. The Century of Progress, the Chicago International Exposition of 1933, has science for its theme and in its exhibits will attempt an international demonstration of a century of progress in science and its application to the world's industry.

Continuing with the plans for the fair, the Major predicted an exposition, not larger than others of the past, but one that would be different from all others—"an exposition in which each group of exhibits will tell such a story that the visitor, in spite of himself, will be compelled to stop and examine."

In the section immediately following will be found a running account of the proceedings of the conference. This, in turn, is followed by the story of the Fourth National Fuels Meeting, with a special presentation of the session devoted to atmospheric pollution. Finally comes the report of the Midwest Power Show.

Executive Committee of the Fifth Midwest Power Engineering Conference



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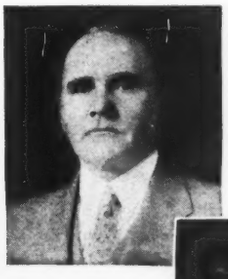

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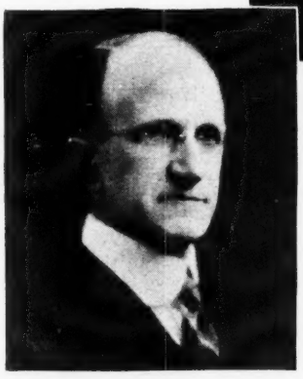

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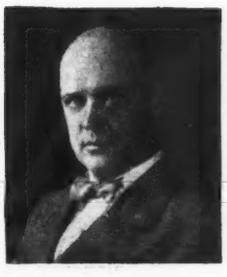

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Power Economics and Prime Movers Discussed by Power Conference

Fifth Midwest Power Engineering Conference reveals trends in distribution of power, steam and refrigeration, points to metallurgical progress to meet high-temperature requirements. Marks prime mover developments in steam, water power and oil engine plants

Power Economies

AT THE INITIAL session of the Fifth Midwest Power Engineering Conference, with C. F. Hirshfeld presiding, three papers on the general subject of power economies were presented. A. H. Kehoe, of the United Electric Light & Power Company, discussed "Balancing Plant Investment with Operating Cost." H. W. Eales, of the Byllesby Engineering & Management Corporation, pointed to "Advances in Electrical Distribution." John M. Drabelle, of the Iowa Railway & Light Company, spoke on the topic "Dual Purpose Power Plants and Commercial Distribution of High-Pressure Steam."

C. F. HIRSHFELD
Chairman Power Economies Session

A. H. Kehoe, in his paper on "Balancing Plant Investment with Operating Cost," defined and analyzed the principal elements of economies that should be given consideration in any power undertaking, such as the fundamentals of corporate finance; the balancing of the total cost of a proposed change in plant, including operating cost, with the earnings that are to be expected as a result of the change; the establishment of plant investment; and balancing of fixed charges and operating costs.

As a matter of day-to-day operations, it was the speaker's thought that the economic result sought in all cases is to lower all costs; but since this only can be done to the maximum degree by providing the proper balance before any new investments are made, it is essential that operators, constructors and designers each appreciate all the factors required to make up this balance. It is insufficient to treat some of these as theoretical determinations which cease to be of value once a main design principle is established. They are active factors which should be regularly revised as results show changes are required, and should form the basis of operations and of construction as well as of design.

It was the author's judgment that successful balancing of operating and investment cost in the ultimate analysis is a matter of careful study and experience, both as to what the operating costs and the fixed charges will be. Operating charges depend upon proper supervision as well as the state of the labor and material markets, while fixed charges have the additional element of property values to consider. Careful estimates frequently checked by experience to date are required if the entire system is to be designed, constructed and operated to render power service worth more to the buyer than it costs the utility to supply the service. In no other way can he be expected to make increasing use of the product. If proper conditions can be made to obtain, it is reasonable to expect an increasing use by the public up to each individual's maximum possible requirements. This will result, in due time, in the lowering of unit cost to the advantage of all users of the service.

History of Electrical Distribution

IN HIS SUMMARY on electrical distribution, H. W. Eales made it apparent that advances have taken place in all phases of the electrical distribution system, and that the present trend is toward the development of alternating-current networks of low, intermediate and high voltages not for only local but for broad areas. The effect of the improvements in the various component parts of the system and the understanding of the problems of interconnection have made possible the success of actual operation of systems distantly interconnected, all tending to give most reliable service to the user at lowest cost.

Another factor affecting the nature of early development consisted in the use of direct-current motors for driving elevators in tall office buildings. This, in turn, resulted in highly concentrated direct-current networks supplied from substations in the network area, which received alternating-current power at generated voltage from stations situated reasonably near. The growth of these systems continued, and even today in the largest metropolitan centers the direct-current network is still the major source of supply to the downtown business sections.

In time, requirements for coal, land and water compelled the location of large stations some distance from the load, requiring collective concentration on the problem of improving the reliability of the system. It remained for the development of the so-called multi-voltage direct-current elevator motor to revolutionize the general attitude on distribution. Use of an alternating-current motor driving a direct-current generator to supply the direct-current elevator motor made possible an alternating-current, instead of a direct current, main in the city streets. Simultaneously a rapid advance took place in the establishment of alternating-current networks in congested city districts.

Apparently, actual building of plants close to the consumer has developed the fundamental principles of reliable supply. An analysis of power systems over the country reveals that the same application is being made gradually to alternating-current systems of higher voltages. Circuits of 33,000, 66,000 and even 132,000 volts are now found in connection with delivery of current to metropolitan centers, and are used very much today as the lower-voltage circuits were 25 years ago.

In distribution, establishment of so-called network and intermediate volt-

ages of 4,000 volts, 13,800, etc., indicates an inevitable trend toward interconnection of circuits of all voltages.

In conclusion, the author outlined up-to-date typical practices in the power system of such cities as Pittsburgh and Chicago.

Complete Utility Service

THE PAPER by John M. Drabelle dealt with utility power plants designed to supply complete, that is, mainly electrical energy and steam for heating and process. Industrials, he said, have increased greatly in size, and in most cases are in position to finance a private power plant. They have at their command steam pressures ranging from 450 to 1,200 lb., and may efficiently recover byproduct power from the process steam. The smaller industrial plants are offered a multiplicity of prime movers ranging from small back-pressure turbines to oil engines, with heat-balance systems to insure high economy. And well-trained men are available to build and operate these plants.

To retain its light and power business, the utility must be prepared to meet the various demands of different users, supplying power and steam, and, where it may seem desirable, operate in parallel with the industrial plant to maintain the heat balance. To illustrate what had been done along this line the author reviewed the salient features of a number of recent plants that had been designed to meet these new problems, such as Deepwater, the Southeastern Production Company's plant at Mobile, the Baton Rouge plant of Louisiana Steam Products, Inc., the Western Electric plant at Point Breeze, two stations at Rochester, and the arrangements made by the Iowa Railway & Light Corporation to supply the Quaker Oats Company, of Cedar Rapids, with power and steam.

K. McH. Irwin, in discussing the paper, pointed out that Deepwater and other plants mentioned were "tailor-made" jobs in which the steam and power loads were known, so it was simply a matter of setting up a rate to get proper returns on the investment. In going into the business generally, it would be found that there would be many irregularities requiring careful study before it would be possible to establish suitable rates.

C. F. Hirshfeld advanced the idea that the light and power company is a trustee to its customers, and, as such, should supply whatever character of service is required at minimum cost. It was a question, however, how far the trustee should take chances. Would the utility be justified in taking over one industrial which in a comparatively short time might become insolvent or change the product and probably change the steam and power demands? Balance and many other things must be considered. Before undertaking combination service each case must be carefully weighed.

Refrigeration And Ventilation

AN EVENING SESSION with two papers was devoted to refrigeration and ventilation. Chairman A. H. Baer, of the Frick Company, called upon W. H. Carrier to present his contribution, "New Applications of Refrigeration in Air Conditioning." He was followed by George A. Horne, vice-president and chief engineer of the Merchants Refrigerating Company, on "The Future of Central Station Refrigeration."

Central Refrigerating Service

CONTRASTED with the power, lighting or heating central station systems, the central station refrigerating plant, said Mr. Horne, is but an infant. Owing to the enormous development of the smaller type refrigerating unit, most engineers apparently have lost sight of the fact that under certain conditions it is more economical to distribute refrigeration direct from a central station refrigerating plant. The author reviewed certain engineering factors governing the development of these plants, such as the character of the power plant, the pipe line, and the insulation.

Three fields in which the central station refrigerating plant will be called upon to function are: General refrigerating service for large buildings, air conditioning, and, in certain residential localities, apartment house refrigeration. The author commented on each field, and briefly described an existing station in the center of the wholesale produce, dairy products and general food business in New York City. One of the interesting features in the plant is the anhydrous ammonia meters that gives accurate information on the precise tons of refrigeration at all times.

ALVIN H. BAER
Chairman Refrigeration and Ventilation Session

Discussing the paper, A. J. Authenreith felt that inherent characteristics are responsible for the slower development of central station refrigeration in contrast with water, gas and electricity. Outstanding factors in this situation are, relatively few companies offering the service, little active promotion, and the uncertainty of universal application.

Factors favoring refrigerating service to a building are simplicity, economy, reliability, safety and the releasing of space that otherwise would be occupied by refrigerating machinery. Diversity of the various services as to the hours of their load would give a fair load factor to the station, whereas many single installations operate on low load factor. Of interest to the power man, drives in these central refrigeration plants doubtless would be all synchronous motors, whereas if the load were broken up in small units when refrigeration is needed the drive might take any form. An adequate supply of cooling water generally could be obtained at lower unit cost by the central plant. Construction of the brine distribution system entails some cost, and the brine to fill the system is an item. On the other hand, the brine in the system also may be considered as refrigeration storage to aid in meeting short peaks.

O. A. Anderson expressed the view that central station refrigeration added another avenue of approach in solving many refrigerating problems. In part, it may be a solution to certain packing house difficulties.

T. J. Carlson gave 80c. per unit per month as the operating cost of a multiple-unit system, which compares favorably with the central station rate.

Comfort Via Refrigeration

USES OF REFRIGERATION in air conditioning for industrial work are rapidly increasing, but according to W. H. Carrier by far the greatest field lies in air conditioning for human comfort. More than 75,000 tons of refrigeration are now used in the United States for this purpose, involving a demand for power, including auxiliaries, of 135,000 hp., and this is only the beginning.

Physiological and mechanical requirements were outlined and the various fields of application enumerated. In summarizing engineering data, tabulated power requirements for department stores, office buildings and theaters were given, as well as a table of costs for complete systems of heating, ventilation and air conditioning, summer and winter, for different types of building. The table not only gave the unit cost of the installation, but the operating cost as well, including interest and depreciation, with the power cost as a separate item. Both of these tables will appear in an early number of *Power*.

Because of the new figures on operating and installation costs of air-conditioning plants, Samuel R. Lewis commented favorably upon Mr. Carrier's paper. In his opinion, too much

emphasis cannot be placed on the fact that cooling air for comfort really means drying air for comfort. Until recently this could be done only by chilling it below the dew point, condensing out the moisture, and then heating the air back up to some temperature close to its original temperature. Now it is possible to remove the excess moisture from the air by absorbing it into a water-hungry sponge-like material which can be regenerated by heat. In some cases, using this process, where there is a cool city water supply, it is possible to eliminate refrigeration entirely, and in all cases at least reduce the amount of refrigeration to that needed for a few degrees reduction in the dry air temperature.

Treated air of different characteristics has been delivered to separate rooms or zones of a building by means of thermostatically controlled mixing dampers that vary the proportion of warmer or cooler air from central air supply reservoirs, or by varying the amount of recirculated air in proportion to the amount of conditioned new air. There is a decided possibility, said Mr. Lewis, that a better way to secure the necessary control will be by local coolers, in the rooms themselves, with electric fans under automatic control that will recirculate the air in the rooms, while the central supply system may inject or recirculate only enough super-dry air to maintain control of the humidity and to provide for replacement of such air as must be withdrawn through lavatories, kitchens and similar rooms for which exhaust ventilation and no recirculation is imperative.

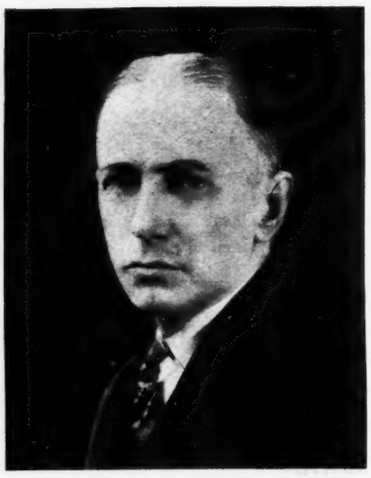
The speaker's experience had indicated that successful results could be obtained in both large general offices and in small private offices with ceiling introduction and removal of the air used for ventilation.

Sam C. Bloom commended the progress that has been shown in the use of recirculated air for tempering the conditioned air. In the Lewis arrangement the method is to introduce definite quantities of air per person, and alter the proportions of the conditioned and recirculated air. In this way adequate ventilation can be obtained with less outside air than ordinarily required.

It would be perfectly feasible, he thought, to eliminate recirculation of the air and simply admit the small quantity of fresh air needed. Low-temperature air could be introduced horizontally overhead, in narrow columns, so that it would descend and mix readily with the air in the room.

Prime Movers

FOUR PAPERS made up the prime movers session, over which Alex D. Bailey presided. Prof. A. G. Christie reviewed "Trends in Steam Turbine Development." John F. Ferguson pointed to the steam engine as the coming industrial prime mover for operation at high pressures. H. F. Shepherd showed "The Influence of Use on the Design of Internal-Combustion Engines." L. F. Harza discussed "Water Turbines of the Propeller Type."



ALEX D. BAILEY
Chairman Prime Movers Session

The Trend in Steam Turbines

PRESENT TRENDS of steam turbine development, said Prof. A. G. Christie, are toward the use of higher steam temperatures and pressures; increased capacities at the various speeds and increased output from a single casing; the employment of better materials for turbine parts, and particularly for blading; higher efficiency over a wide range of load; adjustment of the turbine more closely to the particular requirements of service; and the development of binary fluids for use in turbines. The effect will be the production of larger, more reliable and more economical turbines.

With materials now available and parts designed so that the working stresses will lead to a rate of creep of 0.01 per cent per year, turbines can be built for steam temperatures up to 900 deg. F. with assurance of satisfactory operation, while units for 1,000 deg. F. can be constructed with every hope of successful operation throughout their useful life.

Steam conditions in future stations probably will be standardized as follows: Without reheat, 400 lb. and 750 deg. F., 700 lb. and 850 deg. F.; with one stage reheat, 1,400 lb. and 750 deg. F., 2,000 to 2,500 lb. and 900 deg. F. In the latter case two stages of reheat may be used if high efficiency is desired.

Although these considerations apply, in general, to large central stations, the gains from increased temperatures and pressures are equally applicable to industrial plants. In fact, when such plants operate without vacuum, or exhaust against back pressure into a service main, the proportional gains from using high pressure and high superheat are larger than in condensing stations.

Use of turbines of larger rated capacities result in several economic gains per kilowatt, such as less floor space, decreased weight and lower first cost. Efficiencies tend to increase with higher turbine capacities, though at a lesser rate in the largest units. Reduction in weight and higher efficiency over lower speed conditions are leading to a wider use of large turbines at 3,600 r.p.m.

Blade tip speeds up to 1,150 ft. per second and high moisture content in the exhaust steam from the use of large heat drops at high efficiency are demanding improved materials. Stainless steels at present seem best suited for long blades. A steel with about 12 per cent chrome and 0.1 per cent carbon is giving much promise for such service. To resist erosion on the back of the inlet edge of the blade, properly heat-treated stainless steels and some nickel alloys seem best. Plating the edges of these blades with chromium, or spraying coatings of tantalum, sheathes of Hecla and other metals, coatings of stellite, and nitriding, also appear to resist erosion.

Efficiency in turbines is largely a matter of paying the higher cost of improved designs. Efficiencies of 82 to 85 per cent at the coupling are obtained on some American turbines, while an efficiency of 87.7 per cent at the coupling is claimed for a European turbine of 85,000 kw. capacity. Better performances may be expected to result from lower leaving losses, from reduction in moisture in exhaust stages, from improved blading in the high-pressure section, and from a greater combination of impulse and reaction effects in all blading. Thermal efficiencies possible by the various bleeder and reheating cycles were tabulated. Adjustment of the turbines to a specific service is calling for co-operation between manufacturers and the engineers of the purchaser to secure the most economical installation.

In the binary-fluid field the success of the mercury turbine is encouraging attempts to develop processes to use other materials than mercury, such as diphenyl, diphenyl oxide and zinc ammoniac.

Commenting on the probable limiting performance to be expected of a steam turbine, it was the author's thought that this has not yet been approached, and American economic conditions never may warrant the plant investment to achieve this ultimate end. Probably the best estimate of this limiting performance, within the bounds of present knowledge, is that for a large plant with steam at 2,500 lb. and 1,000 deg. F., having two stages of reheating to the same temperature, and with six stages of bleeder heating, leading to a station heat rate of about 9,500 B.t.u. per kilowatt-hour of net output.

FLAT PERFORMANCE CURVE IMPORTANT

E. H. Tenney was particularly interested in a turbine referred to by Professor Christie in which there is only 100 B.t.u. per kilowatt-hour variation in the heat consumption from 55,000 to 115,000 kilowatts. This he considered a significant trend, for although it is

theoretically possible to load each turbine in a system near its best point, actually, with swinging loads and the necessity for rolling standby, it is seldom achieved. The technical skill required to evaluate all the variables entering into the problem of dividing the load among the units of a plant for each hour of the day is beyond the average heat-balance or switchboard operator, and the type of man who can handle the problem usually is not content with such routine work.

To indicate the result of high-temperature steam on boiler construction, Mr. Tenney gave the following data: With 450-lb. steam, 750-deg. total temperature and 330-deg. feed water, about 900 B.t.u. is added to the steam in the boiler or economizer and 183 B.t.u., or 16.9 per cent, is added in the superheater; with 2,200-lb. steam, 900-deg. total temperature and 480-deg. feed water, 675 B.t.u. is added in the boiler and economizer, and 290 B.t.u., or 30.1 per cent, in the superheaters. This doubling of the amount of heat added as superheat is going to complicate boiler and superheater design, probably resulting in expensive radiant superheaters. It was his contention that the extra initial and maintenance cost of these superheaters should be balanced carefully against the improved turbine room performance before higher temperatures are adopted.

Professor Christie thought this distribution of surface between boiler and superheater interesting, as ultimately we may use the Loeffler boiler, which is all superheater and no water tubes.

Q. M. Crater commented on the progress that is being made with alloy steels in meeting the creep situation. Chromium plating, coatings of stellite, nitriding and other methods apparently are solving the problem of blade erosion.

In outdoor stations there seems to be a great deal of interest at the present time. Depending upon the conditions to be met, savings up to 17 per cent of the cost of the station can be effected.

High-Pressure Steam Engines

OWING TO THE trend toward higher steam pressures and the demand for higher efficiencies in the generation of byproduct power under back-pressure operation, the steam engine is being revived, and, in the opinion of Mr. Ferguson, the improved designs of reciprocating units will open up a new era in industrial power development.

As the initial steam pressure increases, thermal and mechanical losses generally are reduced. With the steam turbine these losses go up with the pressure. Broadly, these characteristics designate the engine as a high-pressure machine, and the turbine as the most efficient low-pressure prime mover. The author outlined the future field of the engine, gave relative economies of turbine and engine, spoke of 850 deg. F. as a safe temperature to apply to reciprocating engines, and indicated future types, piston speeds and sizes in a single unit up to 25,000 kilowatts.

L. Hausmann, of the Westinghouse Electric & Manufacturing Company, took exception to the rather low efficiencies credited to the steam turbine in one of Mr. Ferguson's charts. Aside from that, in low-capacity plants, the fixed-charge burden generally indicates that the owner would not be warranted in going above 350 to 400 lb. pressure. In small plants of 1,000 to 2,000 kw. capacity the fixed burden becomes so enormous that high-pressure operation is not justified. To make the plant economically sound, dollar efficiency must be regarded. In his opinion, few industrials are warranted in making their own power, except those needing large quantities of steam. In response, Mr. Ferguson stated that unit plant cost seemed to work out lowest for a pressure of 2,000 pounds.

Oil Engines

ACCORDING TO Mr. Shepherd the internal-combustion engine has become the pioneer in the spread of power over the globe. He referred to the many uses of this type of prime mover in various fields and showed how the needs of the user have governed the design and development of the varied engine models. The author discussed simple two-cycle, multi-cylinder vertical, and compressor engines, covering applications, features of design, and the adaptation of accessories to meet special needs. The stepped shaft has recently come into existence. The box frame has been accepted universally. Much attention is being given to differing flywheel requirements, and the necessity of balance is gradually superseding any prejudice against a multiplicity of parts.

By means of numerous slides it was made evident that installations and accessories have been wonderfully improved. It is now possible to supply an engine with clean air, cool and clean water, cooled and clarified lubricating oil, and clean fuel in almost any situation. Foundations provided, whether the concrete of stationary plants or the steel of ship, locomotive or shovel, are good permanent structures. Cork insulation and well-balanced engines eliminate all evidence of diesel power in large city buildings.

Edgar J. Kates suggested that the completely automatic type of diesel plant recently put into successful operation will undoubtedly influence the design of engines to be used in this new diesel application. The plant consists of several diesel-electric generating units operating in parallel with a storage battery and booster, all controlled automatically by electrical means.

Generating units are started and stopped in accordance with load requirements, line voltage is maintained constant without flicker regardless of load surges, and all of the supply services to the engines are fully safeguarded. For instance, the jacket water discharge

Thoughts From the Conference

A. H. KEHOE—In designing a plant consider *all* the elements.

H. W. EALES—The trend to higher distribution voltages and interconnection will continue.

JOHN M. DRABBELE—Utilities must be prepared to sell steam as well as power.

W. H. CARRIER—Human comfort, through air conditioning, is the greatest field for refrigeration.

GEO. A. HORNE—Refrigeration from central stations may be cheaper.

A. G. CHRISTIE—The steam plant of the future may commercially achieve 9,500 B.t.u. per net kilowatt, using steam at 2,500 lb. and 1,000 deg. and six-stage bleeding.

JOHN F. FERGUSON—The steam engine is the most efficient prime mover for high steam pressures.

H. F. SHEPHERD—The oil engine has become the pioneer in spreading power over the globe.

L. HARZA—Water wheels with articulated blades will find increasing application in low-head plants.

W. H. ZORN—In the Delray plant, recently completed, 45 electric welders were working during peak activity.

S. E. TRAY—Every evaporator should be equipped with an integral steam purifier to prevent carryover.

temperature is kept constant, independent of the inlet temperature, and in case of failure of the primary source of supply an emergency source is automatically fed in. The lubricating oil pressure is safeguarded by an electrical device which, if the pressure falls to a dangerous point, stops the engine and starts another unit, all automatically.

When an engine is started, it cannot fire until the normal lubricating oil pressure has been built up. Though for the sake of complete independence each engine has its own fuel supply system from the main storage tank, nevertheless interconnection of the fuel overflows keeps every engine supplied even if one of the fuel-transfer pumps should fail. By electrical means the load on each engine is maintained within the desired range for best performance, between 40 and 100 per cent of rating, and all momentary peak loads on the engines are avoided by transferring them to the storage battery.

Designs Are Simplified

The significance of these factors in influencing the design of the engine is almost self-evident. The air-starting equipment is completely eliminated. This makes possible the simplification of the cylinder head design and also of the camshaft. It also does away with all air piping, valves, tanks and compressors, thus materially reducing engine cost.

Because the engines operate in closed engine rooms supplied with filtered air, the enclosure of valve gear, pumps, etc., can be omitted, as appearance while operating is not nearly so important as accessibility while being inspected.

The fuel-injection system and the governor can be of the simplest type for constant-speed operation. No provision need be made for good combustion at no load or idling, as the engine will never be run under such conditions. Manually controlled engines in electric service, though running at nominally constant speed, require occasional hand adjustment of the governor for paralleling and for regulating load or voltage. In automatic plants, however, governor adjustments are seldom required, and can be made while the engine is at rest, thus permitting a simpler governor design.

Propeller-Type Water Turbines

Increasing economy of steam generation, said Mr. Harza, has necessitated reducing the capital investment in hydro-electric projects, particularly the low-head developments, because they are the most expensive. The higher speed does not much reduce the cost of the turbine, but does permit use of a cheaper generator that, owing to its higher speed, operates at slightly better efficiency. Between 1912 and 1915 the development of speed in the Francis-type turbine having reached an approximate limit, a radical departure was made almost simultaneously in Europe and America by introducing the so-called "propeller" turbine, which is adaptable generally to the range of heads below 60 feet.

Even a more radical step than the propeller type turbine itself was the articulation of the propeller blades at the hub to permit change of blade angle under different conditions of operation. Progress has been made from manual adjustment of these blades to automatic

R. F. SCHUCHARDT
Chairman Electrical Developments Session

change of the blade angle from the governor for every change in the opening of the regulating gates, and therefore every change in load. The latter design, known as the Kaplan turbine, has grown in favor in Europe and recently is proving popular in this country.

Curves were presented to show that the design of higher-speed types of turbines had been accomplished, in general, with some sacrifice in maximum efficiencies and quite universally with a reduction in the range of efficient operation under varying loads. As the speed type of the turbine is increased it is necessary to run at more nearly constant load, and with increasing speed the point of best efficiency approaches closer to full load, leaving less margin for absorbing sudden increases.

Reference was made to the almost universal overspeeding of turbines beyond the speed at which they should be operated, and the use of turbines of higher speed type than best adapted to the given head. Relative advantages of fixed- and adjustable-blade turbines, their relative costs, the condition to which each type is best adapted, and the relative number of units for a specific project, were considered.

In conclusion the author anticipated many cases of favorable operating conditions where the fixed-blade turbine will be satisfactory and more economical, but predicts a prosperous future for the Kaplan unit, as its operating curve is so favorable for the conditions usually existing in low-head installations.

W. M. White certified to the correctness of the curves shown in Mr. Harza's paper, but did not agree that all manufacturers have shown a tendency to go to excessive speeds. Personally, he had fought against this trend, as he thought it only meant grief to the builder. In his opinion, smaller plants are the reason for the quicker adoption of the Kaplan turbine in Europe. Mr. White predicted increasing activity and further development in the low-head plant.

High-Temperature Metals

An exhaustive review of high-temperature metals was presented by L. W. Spring, chief metallurgist of the Crane Company, the occasion being a noon luncheon held under the auspices of the American Institute of Mining and Metallurgical Engineers, with C. C. Whittier president. Mr. Spring indicated that the power plant designer already has designed for 825 deg. total temperature and is asking for materials to stand service for ten to twenty years at 1,000 deg. F., which is a low red heat in a dimly lighted room. The fact that steel at this temperature has only one-half its normal temperature strength indicates the seriousness of temperature increase. Using stronger material or increasing the thickness takes care of rising pressures.

The speaker dwelt at some length upon the flow, or creep, situation; discussed strength vs. excess ductility, fatigue of metals and corrosion; commented briefly on some of the new steels; and outlined the requirements and construction of power plant equipment, such as the boiler shell, the steam turbine, piping, pressure containers, valves and valve seats, with particular reference to the use of Nitralloy as a new seating metal.

Electrical Development

R. F. Schuchardt directed the electrial session, which featured three late developments in the field. Audley E. Harnsberger, mechanical engineer, of the Pure Oil Company, summarized "Power Requirements for the Pumping of Oil, Gas and Gasoline." W. H. Zorn outlined the experience of the Detroit Edison Company in "Arc Welding in the Power Plant." C. W. Stone of the General Electric Company, talked on high-voltage direct-current transmission.

Pumping Oil and Gas

During 1929 the oil production of this country averaged 80,000 gal. per minute. The bulk of this flow is pumped at pressures up to 800 lb., not only once, but as many as twenty times, in moving the oil from the fields to its markets. During the same year more than 5 billion

cubic feet of gas per day was delivered through pipe lines, and present construction will add considerably to that output. Lately the movement of gasoline by pipe lines is being carried out. Power requirements and the equipment used for transporting crude oil, gas and gasoline, differ, so the handling of each product was considered separately by A. E. Harnsberger in his paper on this general subject. Details as to equipment and choice of drive, whether steam, gas, diesel engine, or electric, will be given later in *Power*.

Advantages of Electric Drive

W. H. Steuve, of the Oklahoma Gas & Electric Company, discussed the paper at length, so that it will be necessary to present the details later. Setting up a hypothetical case, he compared oil engine and electric motor costs. In substance, he appeared to favor electric prime movers for crude oil and gasoline transportation. A careful analysis of operating costs of prime movers, based on certain known installation costs, with all the variables taken in account, disclosed that electric power rates, as now offered by most of the ultilities, would permit electric motors to show cheaper operating costs over long periods of time (fifteen to twenty years) than corresponding costs of oil engine prime movers. Advantages enumerated for the motor are, lower cost of station installation, less attendant labor, practically no maintenance, high mechanical efficiency of motors, low power rates and no water supply necessary. New station installation records made in the last several years on main trunk lines indicate that approximately 30 per cent of the prime movers have been electric motors. Improved high-line construction has tended to lessen interruption of service, an objection frequently offered against the use of motor drive. Surveys in both Oklahoma and Texas, where stations are located on lines having one-way feed, disclosed that the maximum outage over a period of a year, had averaged less than ½ of 1 per cent of total elapsed time.

In considering compressor installations for natural-gas transportation, the tendency is to install reciprocating gas-engine-driven units. During the last several months however, considerable thought has been given to centrifugal compressors using electric drive. The unit consists of a six-stage centrifugal blower pump directly connected to an induction motor. Future installations of this character will depend on the success of the present unit.

V. Gerbereux, of the Worthington Pump and Machinery Corporation, confirmed the advantages attributed by the author to the centrifugal pump, which offset the fact that it is less efficient than the displacement type. Continuing, he said that the flexibility made possible by using two so-called "half units" operating in series, each "half unit" being a single pump for full capacity at half the station pressure, will materially reduce the power required at part loads. With one of the half units operating at half the normal station pressure, it is often possible to pump two-thirds the quantity of oil through the pipe line that is possible with full station pressure. Considering that under these reduced conditions the power load is only half of that required for full station pressure, the horsepower rate per barrel pumped has been reduced.

The use of automatic controls on the electric driven centrifugal pump makes it possible to start and stop "half units" or full stations at exactly the time this is desired, resulting in less waste power during starting and stopping periods. Automatic controls also reduce the required number of station attendants, which is important in inaccessible districts.

One of the principal uses of centrifugal pumps, he said, has been for boosting the capacity of existing pipe lines. The booster station is located between two oil-engine or steam-driven displacement pump stations and the booster station often is automatically controlled from the previous main station. This boosting has resulted in larger capacities being handled in many pipe lines today. Centrifugal pipe-line pumps are now being used to boost the capacity of pipe lines to the rate of 70,000 bbl. per day, and these pumps have an ultimate capacity of over 90,000 bbl. per day.

Arc Welding in the Plant

No attempt was made by Mr. Zorn to discuss the technical side of welding. Instead he sketched briefly the development in welding by the Detroit Edison Company and its application to construction and maintenance in the power house. With this company, welding as a major tool dates back to 1925. At that time the company possessed five or six electric welding units and twenty oxy-acetylene outfits, the latter being used principally for cutting. In 1929 the number of welding units had increased to 60 and 80, respectively, and during the four years welders had increased from 5 to 100. In the Delray plant recently completed as many as 45 electric welders were working during peak activity.

Building up a competent welding organization by the training and selection of skilled operators is the hardest problem to be faced. Once this problem has been met and solved, most of the other problems, said Mr. Zorn, will solve themselves.

Many examples of welding work done at Detroit Edison plants were described and pictured in a *Power* article by Mr. Zorn, published June 4, 1929.

Discussing this paper briefly, I. L. Wise reviewed Commonwealth Edison experience in welding low-pressure and small sizes of high-pressure piping, building steel work, air ducts, casings and tanks. The field test is visual, and the policy is to train their own welders.

Thyratron Magic

Intense interest was taken in the paper by C. W. Stone, of the General Electric Company, who described some of the general characteristics of the Thyratron and some of its applications to electric power systems. Two distinct types have been developed, one called the mercury-pool type, and the other the hot-cathode type. In most other types of tubes the amount of current that flows through the tube is controllable by the polarity and the voltage impressed on the grid, but in the Thyratron no current will flow unless the grid is made positive, and if the grid is made more positive or reduced to zero, or even if the polarity is reversed, the current flow is unchanged.

If an alternating current is connected to the tube, current will flow for half the complete cycle, but it will not flow unless the connections are reversed for the other half cycle, and not unless the grid potential is made positive.

If, after the first half cycle of current flow, the grid is made negative, the next half wave, when the impressed alternating current reverses, will not start as the door is closed; hence, the tube is essentially a relay which either closes the circuit or opens it, but has no control over the amount of current flowing while it is flowing, except that the amount of current can be controlled by the period of time that the door is open.

By suitable connections, two tubes can be used, one for the positive half wave of alternating currents and the other for the negative half wave. Again, by changing the connections, it is possible to make the direction of flow of current change by first allowing the current to flow in one tube and then in a second tube. With alternating-current applied to the Thyratrons in the first case, the flow from them will be unidirectional, or direct current, and in the second case with direct current connected alternating current will result.

Mr. Stone went into some detail on the various applications of the tubes, and in conclusion summed up some of the advantages of direct-current transmission and distribution. All generators will be operated at practically unity power factor, and can be designed for any frequency. Thyratrons operating as rectifiers can be used for all switch operations. The amount of power flowing into a short circuit can be limited to even less than full load on the circuit. Troubles incident to parallel operation of units and synchronizing will disappear. The switch house and cable work from the plant will be much simplified. Reactance and capacity effects will disappear, and the only limit to the distance of transmission wil be the ohmic resistance of the conductors and the costs of such installations. The costs of the transmission circuits themselves should not be over half present costs.

Mr. Stone made it plain that all the problems of generation and distribution of power by this new system have not been solved. All the things mentioned

have been done in the laboratory, but patience and time will be required to work out the details, in co-operation with the user.

At the conclusion of the talk a veritable flood of questions indicated the intense interest in this development. Many of the participants expressed a desire to try out the equipment and help work out anticipated difficulties in practice.

Feed-Water Problems

PROF. F. G. STRAUB of the University of Illinois, presided at the session devoted to boiler feed-water problems. Two papers of wide current interest were on the program. S. E. Tray, of Sargent & Lundy, presented developments in evaporator practice and design, and H. S. Whiton, of the Byllesby Engineering & Management Corporation, dealt with the mechanical and chemical problems in the control of boiler-water concentration.

Evaporators

IN HIS PAPER on developments in evaporator practice and design Mr. Tray went into sufficient detail to show when evaporators are justified, indicated a number of applications in central stations and industrial plants, and outlined general operating practice, including details of additional treatment necessary to provide pure water for boiler feed. Evaporators, he said, should be evaluated not only as a means of producing distilled water, but as equipment capable of performing several additional functions, including that of a feed-water heater and deaërator. These additional uses sometimes make it possible to justify their expense on large quantities of make-up water.

Relative to single- vs. multiple-effect evaporators, the latter introduces complications and is more expensive, and, if the evaporators are connected in series, has the same capacity as the single-effect. Economy is the reason for its use, as the steam consumption is reduced in proportion to the number of effects installed.

Evaporators usually are designed with a minimum temperature difference of 20 deg. between the incoming steam and the outgoing vapor. With less difference the rate of heat transfer is impaired, owing to poor circulation in the shell. A maximum temperature head of about 100 deg. is the limit beyond which violent ebullition of the water would require excessive separator space to prevent entrainment and carryover.

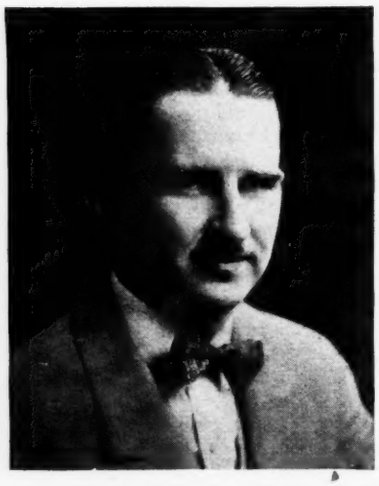
Other recognized facts in evaporator design are the need for slightly greater surface in each effect of a multiple unit than in a single effect of the same capacity, and the need for basing the design not only on the requirement for distilled water but also on proper association with the heat balance of the entire plant.

Single- and double-effect evaporators at Powerton station, with their respective efficiencies, were cited as typical examples, and reference was made to the "reducing-valve" evaporator such as is used at Deepwater station, where much of the large quantity of steam furnished for process is not available for condensate. Out of the operating experience gained at this station has come two important features that should be incorporated in the general design of evaporators. One is the inclusion, as an integral part of the evaporator, of a steam purifier that will remove the last traces of impurities and carryover in the vapor. Also, in large evaporators using steam under pressure in the coils, the use of welded construction on the shells is desirable to care for expansion caused by the differences in temperature between incoming water and outgoing vapor.

In practice, an important factor to be considered is the place in the heat cycle occupied by the evaporator. In general, it may be stated that the higher the operating pressure the greater is the ease and satisfaction of operation. Again, chemical treatment of boiler feed water is of paramount importance. It is often used before evaporation, and sometimes afterward. The author gave much attention to this subject.

Controlling Concentration

METHODS of treating feed water and of checking boiler water concentration vary widely in different plants. To give an idea of the range of intricacies met with in practice Mr. Whiton outlined several methods of checking boiler water concentration, beginning with the simpler methods, such as use of the Baumé hydrometer, simple titration test for chlorides, or determination of total alkalinity by titration with sulphuric acid, using methyl orange as the indicator. For more complex treating problems, test procedure may be set up to determine concentration of total salts, carbonate and hydroxide ions, chloride ions, phosphate ions, sulphate ions, pH values, oxygen content and CO_2 content.



F. G. STRAUB
Chairman Water Problems of the Power Plant Session

Regardless of test methods or water treatment, it may be necessary to remove quantities of concentrated water from one or all boilers in a plant and replace with less concentrated water. Any one of a number of methods is available, including the intermittent use of a hand-operated blowoff valve or some system of continuous blowdown with heat exchangers. After commenting on the common methods of removing concentrated solutions from boilers and the methods of checking results, the author made it plain that the method of conditioning boiler water has a marked influence on the amount of blowdown required. In his opinion, the control of boiler water concentration is primarily a chemical problem. Once the chemical problem is solved the mechanical problem is relatively simple, except for the choice of proper materials for the heat exchangers and regulating valves, which may be subject to rapid corrosion and erosion.

AVAILABLE ENERGY LOSS WITH EVAPORATOR

Both papers of this session were received with a great deal of interest. Referring to Mr. Tray's contribution, J. D. Yoder stated that wherever an evaporator is used, considerable energy is lost, the question being how much power could have been saved if the steam had expanded down to the exhaust pressure of the prime mover. Relative costs of an evaporator and water softener were compared. One plant paid the price of installing boilers good for 850 to 900 lb., in lieu of 650 lb. pressure when using a hot-water process system. S. B. Applebaum cited examples of zeolite plants installed to pretreat evaporator installations and listed the results obtained.

Quoting from his experience with evaporators, G. C. Daniels has found that the higher the pressure the greater the liability of trouble from carryover. If scale trouble in the turbine is to be eliminated, the carryover of sediment in the steam must be stopped. Roughly, evaporator water cost about $1 per 1,000 gal., compared to a few cents for treated water.

Mr. Tray admitted that the amount of available energy lost by using an evaporator is quite an item. In the central station requiring 1½ to 2 per cent make-up, the charge is relatively small. More thought must be given to industrial plants, in which considerable condensate does not get back to the boiler.

EXPERTS DISCUSS CONCENTRATION

Discussing boiler water, Dr. R. E. Hall stated that the chemist does not like to run the boiler plant, but does like the opportunity to start with the feed water, follow it through and work with the concentration problems in the boiler. The chemist can see the contamination and prescribe the necessary treatment,

gaging his methods according to the boiler equipment. The Winkler method, as outlined in the paper, has no value whatever, he said, unless the water is absolutely pure. A modified Winkler method must be applied to contaminated water. Professor Straub agreed that in contaminated water the present methods of analyses are of practically no value.

Lucius A. Fritze, discussing proper control of boiler water concentration, emphasized two important facts: That the water within the boiler must be the guide for the conditioning or softening procedure, and that each individual boiler should be treated as a unit. With these two facts in mind the problem of control of boiler water concentration becomes one involving mechanical means under chemical supervision. Concentrations encountered in boilers take three forms: dissolved or entrained gases, insoluble concentration and soluble concentration.

Functions of the two distinct types of equipment for control of boiler concentrations, the sludge deconcentrator and the continuous blowdown system with heat exchanger were discussed at some length and the respective fields defined. The speaker considered each boiler plant an individual problem requiring a careful survey. This survey of the plant and the water analyses reveal the method of procedure for softening or treatment of the water, as well as the type of concentration that would accumulate within the boiler, and the type of apparatus needed for concentration control.

Continuous Blowdown

S. B. Applebaum itemized the recent changes in boiler design that tend to increase the rapidity with which concentration takes place within the boiler, showed how continuous blowoff helps produce dry steam, explained the use of the hydrometer to test boiler saline density, discussed unequal concentrations in various parts of the boiler, and considered briefly blowoff regulating valves. He emphasized the importance of continuous blowoff for evaporators as well as boilers, and considered the reduction of corrosion by continuous blowoff and recirculation of boiler salines.

C. C. Wilcox referred to turbine-blade scale trouble in the plant of the Studebaker Corporation and the elaborate investigations that had been made on boiler water concentration. This plant, Mr. Wilcox said, uses an internal treatment.

E. P. Rich referred at some length to experiences with corrosion in the return lines of the heating system at the University of Chicago. It was his conclusion that in large institutions of the kind and in central steam heating, careful consideration must be given to the carryover of carbon dioxide and oxygen. Infiltration of air into the returns of the heating system becomes a menace, so that every means should be used in design and maintenance to limit this disturbing element.

Power Sites And Subways

At the final session, with General Charles Keller presiding, the papers were of civil-engineering interest. Dr. M. M. Leighton, chief of the Illinois Geological Survey, interrelated geology

GEN. CHARLES E. KELLER
Chairman Civil-Engineering Session

with reservoir power sites. Major R. F. Kelker went into detail on the plans for the proposed Chicago subway system, and Robert Ridgway told many interesting things about the subway system of New York City.

Reservoir Power Sites

For more than 100 years geology has been applied to engineering, and, according to Doctor Leighton, there has been increasing call within the last decade or two for the contributions that can come from a critical geological examination. To date, however, there has not yet come the realization of the wisdom and economy of having a geologist as an essential part of a large engineering oranization.

From the standpoint of geology it is important to keep in mind that in certain sections of the country the problem of sites for dams and for reservoirs may be quite different. In the case of reservoirs it is a matter of water-tightness, and in some instances of additional storage in the formations bordering the reservoirs. In the case of sites for dams, it is a matter of strength and resistance of the rocks and water-tightness in resisting the hydraulic gradient as the rocks now are; likelihood of softening; slipping and weakening and development of leakage as time goes on; peculiarities of the material to be excavated or treated that may present problems of handling and financing; and the seismic status of the region.

There must be the full realization that the present conditions are one thing and the development of different future conditions is another. Every case has its own aspects; no two are alike; and "rule of thumb" cannot prevail. It is a question of the geologist's being a sufficient master in his methods of attack on all of the phases of the case that is before him, from the time of his preliminary assembling of information, through his examination of outcrops and surface phenomena, through the stage of underground exploration, through the laboratory testing, up to and including the interpretation of the entire situation of this site or alternative sites, and the presentation of a clear picture in his report to his client. Then there may follow additional calls on his intelligence and alertness as construction progresses.

Because every case is different, it was not possible to discuss all of the phenomena and methods of work, but Doctor Leighton touched upon a number of fundamentals, traced the physiography of the United States, and discussed briefly geological engineering conditions such as apply to power sites.

Subway Construction

As a timely topic of general engineering interest, Maj. R. F. Kelker outlined the plans for the proposed subway terminal in the heart of Chicago's loop, that will be designed to give operating efficiency to a great transportation system. Numerous slides pictured the construction plans, provisions for pedestrians, traffic, underground services and ventilation of the four-track subway system.

Robert Ridgway, who has been in charge of New York subway construction for some years, and who is also consulting engineer for the Chicago project, told many interesting things about the subways of New York City, which now has 38 per cent of all subway mileage in the world and soon is to have a much larger percentage. The difficulties of subway construction in that city, owing to uncertain rock structure, limited space available, and the tangle of service cables and piping, were portrayed with great interest. Transportation facilities, financing and some indication of returns were other items given attention.

As for engineering difficulties, Mr. Ridgway indicated they would be less in Chicago than in the Eastern city. Wide streets on a rectangular pattern are an aid, and the underground difficulties are not so great in earth as in rock. In making the bore, the rock is always an uncertain quantity, whereas with earth, or even with quicksand, the requirements are definitely known.

Both experts agreed that few cities can justify the expense of subways. They are to be regarded as necessary evils costing from ten million dollars a mile upward for a four-track tunnel.

Coal, Oil and Gas Papers Round Out Chicago Fuels Meetings

Sessions of Fourth National Fuels Meetings devoted to discussion of refinery wastes, anthracite, Midwest coals, gas and oil. Slag-tap furnaces, mixing in pulverized-fuel furnaces, coal byproducts, furnace radiation and the future trend in boiler plants were subjects of other papers

THE Fourth National Fuels Meetings of the A.S.M.E., held simultaneously with the Fifth Mid-West Power Engineering Congress in the Stevens Hotel, Chicago, provided three days of concentrated discussion of fuel and furnace problems.

A program of exceptional breadth and merit was presented, covering refinery waste fuels, utilization economics, coal dehydration, small stokers, anthracite, conversion to gas firing, slag-tap furnaces, bituminous by-products, boiler and furnace losses, boiler selection and Mid-West coals. Several papers dealt with pulverized fuel. Two predicted future trends in steam generation.

The fuels meetings, unlike the sessions of the Power Conference, frequently grouped papers dealing with unrelated subjects. For that reason, each paper in the following report is treated independently, without regard to session in which it was presented.

Burning of Refinery Waste

PROBLEMS associated with the burning of oil refinery waste fuels were discussed by H. J. Klotz, efficiency power engineer, Stone & Webster Engineering Corporation. Mr. Klotz discussed in some details arrangements and results at the steam plant of Louisiana Steam Products, Inc. This plant is required by contract with a large neighboring oil refinery to supply the latters' steam and electric power requirements, and to burn refinery fuel waste up to 50 per cent of the total heat content of the fuel required. These residuals are bought on a heat-value basis at a price which, in conjunction with the rate at which steam and electric energy are sold, requires that they be burned as efficiently as natural gas and fuel oil. The latter are the normal and emergency fuels, respectively, making up the balance of the plant fuel requirements.

The search for high efficiency led to the adoption of mechanical atomizing burners in the face of much advice to the contrary, Mr. Klotz said. The lubricating acid sludge to be burned has a heat value of 10,940 B.t.u. per pound, and the acid tar 9,525 B.t.u. Acid and moisture contents are high and extremely variable. About 15 per cent of the sludges supplied are non-acid in character, and about half of these are strongly alkaline.

In all, it is necessary to burn about 2,000 bbl. of the various sludges a day. The lubricating acid sludge is extremely viscous and requires constant agitation by steam jets, and constant circulation through all piping. The so-called acid tar is more easily handled, but is highly corrosive.

Using suitable piping, the alkaline sludges are easily handled, except that they tend to form deposits, clogging the gas passages.

The sludges are received in lead-lined tanks from the refinery. Reciprocating pumps of especially rugged construction are used. No springs are employed on the pump valves.

After much experimentation, suitable tips were developed, capable of atomizing 3,000 lb. of fuel per burner per hour, corresponding to about 1,800 lb. of normal fuel oil.

Acid sludge is supplied to the burners at pressures between 190 and 200 lb., and at temperatures of from 225 to 275 deg. F. For acid tar the corresponding pressure and temperature are 180 to 190 lb., and 165 to 175 deg.

Aluminum bronze has given fair service in the tips, but search for more durable material is being made.

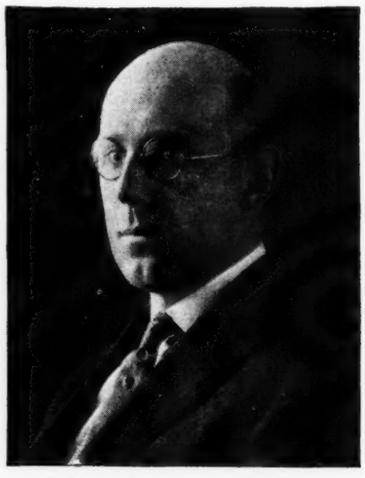
Combination gas and oil or gas and pulverized fuel burners are used throughout the installation. The multiplicity of piping and valves for the various fuels and steaming-out service complicates operation, but it has been found that alert operators quickly learn to handle the equipment.

Mr. Klotz reported that no difficulty

Officers of the Executive Committee of the A.S.M.E. Fuels Division:

W. J. WOHLENBERG (Left) *Chairman*

A. D. BLAKE (Right) *Secretary*



has been experienced in the operation of the equipment for pulverizing refinery coke. He said that the Louisiana plant is burning the oil refinery residuals at capacities much higher than ordinarily attained, and at efficiencies comparable to the best of the normal fuel, oil and gas installations.

Discussing the paper by Mr. Klotz, L. A. Mekler, Universal Oil Products Company, spoke of the combined steam atomization and gas method of burning refinery sludges. With this 90 per cent of the load on a 5,500 sq.ft. boiler was carried by the sludge at an evaporization rate of 8 to 10½ lb. of water per pound of sludge. He also spoke of the great excess of petroleum coke made as compared with the amount pulverized and burned as fuel. He placed the figure at one half-million tons burned to one and three-quarter million tons produced. One plant at Ponca City, Okla., is burning pulverized coke exclusively, Mr. Mekler said. Another thing he pointed out was that petroleum coke burns practically ashless and produces a high percentage of CO_2. This offers possibilities for some enterprising persons to combine the burning of petroleum coke with the manufacture of solidified CO_2.

R. Vroom, of Peabody Burner Company, reported that no sludge is burned at Baton Rouge except with natural gas and mechanical atomization, but that the Humble Oil Company has installed burners with a capacity of 4,000 lb. of sludge per hour, and that other burners of his company have been made which will burn four tons of sludge per hour using steam atomization. He has also burned acid and alkaline sludge simultaneously, but has found some trouble with formation of salts deposits on the burners.

O. F. Campbell, Sinclair Oil Company, mentioned a burner which evaporated 60,000 lb. of steam per hour.

K. L. Martin, the Engineer Company, took note of the objections to mixing oil with sludge in mechanical burners and thought steam atomization generally better. He spoke of mechanical burners now made evaporating 7,500 lb. of steam per hour, while steam atomizing burners are evaporating 85,000 lb. per hour. Some cases of which he knew have efficiencies of 78 per cent for mechanical burners and 84 per cent for steam atomization.

Coal, Oil and Natural Gas Compared

UNDER THE title "Economics of Fuel Utilization," Albert L. Brown, general service engineer, the Consolidation Coal Company, New York, N. Y., presented a comparative study of coal, oil and natural gas in the United States. His emphasis was on the statistical side.

He pointed to recent developments in the natural-gas industry as removing in large measure the restricted territorial use of that fuel. This means, he said, that in the future the relative value of natural gas can better be determined, because of the enlarged distribution area, the greater number of industries served, application to a greater variety of fuel-burning equipment, intensifying of competition between fuels.

Extension of pipe lines to new territories, Mr. Brown pointed out, will subject natural gas to some of the

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burdens and difficulties formerly confined to coal and oil. These include high transportation costs, poor load factors, variable seasonal demands, and improvements in equipment for utilization of competing fuels.

It was his opinion that natural gas will not progress greatly in industries like the electric-steam utilities, where B.t.u. cost is the primary factor. He felt also that the house-heating load is less attractive than commonly assumed, because of its seasonal character. This leaves the industrial fuel demand as the greatest field.

In 1929, said Mr. Brown, petroleum furnished 25 per cent of the total energy supplied in the United States. Increased oil and gas production have gone hand in hand, for geological reasons. Petroleum, he stated, now stands out as the second largest producer of energy in the country. It ranks next to coal, and during the last decade has replaced coal to a considerable extent, particularly in domestic heating.

In 1929, he pointed out, bituminous coal developed 53 per cent of the total energy from all major sources, and anthracite 8 per cent. In all, 591,000,000 net tons of coal was consumed in the United States. To produce it, 654,494 miners were employed in 6,057 mines for an average of 221 days. Each man produced, on the average, 4.21 tons each working day. The average value of this product at the mine was $2.20. The greater part of it, however, the bituminous coal, sold for only $1.78.

Mr. Brown expressed the opinion that the loss of coal tonnage to oil and gas is a temporary condition. He predicted a more intensive study of markets, of coal classification, and of coal preparation and burning by men in this field to meet the new competition. He pointed to the success with which pulverized coal has been applied, and predicted the rapid elimination of hand-fired coal-burning equipment by modern stoker and pulverizing units. He pointed to the rehabilitation of the coal market as essential to railroad and national prosperity, since the movement of coal and subsidiary supplies comprises over 30 per cent of the revenue freight of the railroad.

The following division of bituminous tonnage for 1928, reported by the United States Bureau of Mines, was presented in the paper:

	Per Cent
Railroad fuel	27.7
Coke ovens	16.0
Electric utilities	7.7
Steel works	5.4
General manufacturing:	
Stone, clay and glass	4.6
Metal industries (not incl. steel works	3.5
Food Products	2.3
Chemicals	2.1
Paper, pulp and printing	2.0
Textile and products	1.7
Petroleum refining	0.8
Leather and rubber	0.8
Lumber and wood products	0.7
Miscellaneous manufacturing	0.5
Ice manufactured	0.5
Coal and water gas	1.0
Coal mine fuel	1.1
Other mines and quarries	0.8
Bunkers	1.5
Domestic and all others	19.3
Total	100.0

A similar survey of the distribution of fuel oil for 1929 showed that the railroads used 20.5 per cent, the steamships 24.9 per cent, and oil companies, as local fuel, 15.2 per cent. Gas and electric power plants used 8.52 per cent, and domestic heating 1.94 per cent.

The following table for the distribution of natural gas in 1929 was included:

	Per Cent
Domestic purposes	19.00
Fuel for oil and gas field and natural gasoline operations	36.45
Manufacture carbon black	13.77
Public utility electric generation	5.67
Petroleum refineries	5.67
General industrial purposes	19.44
Total	100.00

Concluding his paper, Mr. Brown urged "that all engineers and other fuel consumers weigh carefully the merits of coal when contemplating the selection of a fuel, study its inherent values (which up to now have only been partly utilized, due to equipment limitations), become more familiar with the production and preparation of coal at the mine, and benefit in a material way by replacing old and inefficient coal-burning equipment."

A paper by Max Tolz, consulting engineer, St. Paul, described a new process for dehydrating low-grade coal.

Discussing the papers of Messrs. Brown and Toltz, L. A. Mekler, Universal Oil Products Company, spoke of the prevailing opinion among power companies that "fuel oil" means an oil of something like 20 to 24 deg. Baumé, while the present available fuel residiums are more like 10 deg. Baumé. The latter, although not generally used by

the big power companies, offer possibilities that warrant attention.

C. Tasker, Ontario (Can.) Research Foundation, discussed the virtues of the several processes for dehydrating lignites spoken of by Dr. Toltz and pointed out that lignites will not coke.

In closing, Dr. Toltz expressed his opinion that in Europe there would soon be regulations prohibiting the burning of coal on grates and that gasification of all coal would be required. He gave some figures on production cost for North Dakota lignites as follows: Cost of mining $1.06 per ton; cost including overhead expenses $1.30 per ton; cost for drying $0.50 per ton; cost for dried product $1.80 per ton.

Symposium on Small Stokers

A SYMPOSIUM on small stokers was presented by T. A. Marsh, president, Modern Coal Burner Company. He severely criticized the engineering profession for its neglect of this field for the larger installations. Action, he said, was finally forced by the coal companies, who, even today, sell 68 per cent of all stokers supplied for plans below 200 horsepower.

Small plant operation, said Mr. Marsh, is the crux of the smoke problem, and no cure for smoke in soft-coal-burning districts can be found until mechanical stokers are generally used in all small plants, including domestic plants.

According to Mr. Marsh, there are, excluding domestic plants, approximately one and one-quarter million logical prospects for stokers in the commercial and semi-industrial fields. Stokers for small heating plants have reached a high state of development, he said, with efficiencies approximately 30 per cent greater than with hand-fired operation. The lower-price coals, with ash up to 20 per cent, moisture 20 per cent, and sulphur 5 per cent, are successfully burned.

Experience has shown, he said, that liberal-sized stokers are necessary. Mr. Marsh pointed to the need for further research on furnace design to differentiate between water-cooled and refractory furnaces, and to establish definite standards for the design of each.

Discussion of this paper revealed a keen appreciation of the possibilities of these small stokers in heating service for buildings, hotels, homes, etc. The constructive and conservative attitude of the Midwest Stoker Association was apparent and gives promise of splendid service in the burning of coal under boilers of 2,000 to 3,000 sq.ft. and less.

J. F. Walter, Iron Fireman Corporation, told of some figures that have been collected from 634 industrial installations and 162 domestic, showing that their combined number is paying 39.44 per cent on the investment as a result of fuel savings over hand firing.

Two Chicago hotels were officially tested under supervision of oil men and architects, with the result that stoker-burned coal showed a saving of 35.5 per cent over oil. These figures were based upon oil at 4¾c. per gallon and coal at $5.15 per ton delivered.

J. R. Sherwood, of Modern Coal Burner Company, gave a general discussion and was followed by C. A. Reed,

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of the Pittsburgh Coal Company, who said that his company is furnishing fuel to 2,300 small stokers (for boilers below 1,500 sq.ft.) in Pittsburgh and over 1,500 in Greater New York. It is the practice, he said, not to furnish the cheapest coal, but to supply a good grade, carefully sized and otherwise prepared to aid in the successful operation of the stokers. He stated that one dealer regularly includes as a part of his installation contracts on all stokers a sufficient supply of coal of his own selection to make certain that the job is properly started and its success insured.

Frank Chambers, smoke inspector for Chicago, considers the small stoker the greatest medium for smoke abatement and is moving to require their installation on all cases where there is 1,200 sq.ft. of steam radiation or 2,000 sq.ft. of water radiation. He also stated that there is need in Chicago for rules covering the application of stokers to existing furnaces and that he is requiring the furnace volume to be one cubic foot per 30 lb. per hour evaporation.

Mr. Beckwith, chairman of the meeting, here stated that the Midwest Stoker Association is now preparing standards for furnace settings which it expects to publish in a few weeks, for the guidance of consulting engineers, architects and others.

M. P. Cleghorn, mechanical department, Iowa State College, spoke of the problem of burning Iowa coals in stokers of the underfeed type. He stated that the best experience so far has been obtained with two 1,000-sq.ft. boilers using forced-draft, chain-grate stokers with the draft through the grates.

Service to Anthracite Consumers

OFFSETTING criticism of the engineer by Mr. Marsh was warm praise by C. A. Connell, general manager, Anthracite Coal Service, Philadelphia, Pa. Mr. Connell pointed to the work of mechanical engineers as an indispensable factor in the improved facilities available to anthracite users. His paper dealt mainly with the domestic field.

The anthracite coal service, discussed in detail by Mr. Connell, was organized to promote effective utilization of this fuel. A survey made in the early part of 1926 showed that most complaints were due to faulty equipment and improper firing, rather than to poor coal, although the coal was invariably blamed.

The survey showed that domestic purchasers of anthracite must be accorded heating engineering service. Anthracite Coal Service at that time consisted of 22 combustion engineers, who were devoting their efforts exclusively to large heating plants and industrial power plants. It was evident that the cost of such service for domestic consumers could not be sustained. As a result, it was decided to give retail coal merchants some training in combustion engineering, and courses were set up in various cities,

Success of the first school, in Trenton, N. J., proved that the plan of training retail coal merchants in servicing was sound, and these classes were continued. Meanwhile the personnel of the anthracite coal service was enlarged and its operation extended from a few cities in the East to the entire anthracite-consuming territory. To date several thousand employees of retail coal merchants have taken the course, said Mr. Connell, their work being backed up by 80 to 100 engineers of Anthracite Coal Service located in thirty cities.

The latest phase of this work is the establishment of the Anthracite Institute Laboratory at Primos, Pa. This laboratory is equipped to make extensive tests of boilers, stokers, thermostats, etc. It is proposed to authorize a special marking indicating the institute's approval of a piece of apparatus.

Domestic Heating With Natural Gas

IN A VERY complete and instructive paper, William D. Edwards reviewed two years of experience with natural-gas heating in Memphis, Tenn., and drew conclusions of interest to users in other districts.

Natural gas approximating 960 B.t.u. per cubic foot is supplied to Memphis from the Monroe, La., field by a 220-mile pipe line 18 in. in diameter.

Gas consumption for projected installations is estimated in two ways. One is to apply a conversion factor to the previous coal consumption, allowing

for estimated differences in efficiency, as well as comparative heat values. The other is to apply the "degree-day" method. As standardized by the American Gas Association, the degree-day for one day is the amount by which the average temperature falls below 65. If this is computed for every day of the heating season, and the results added, one has the degree-days for the year.

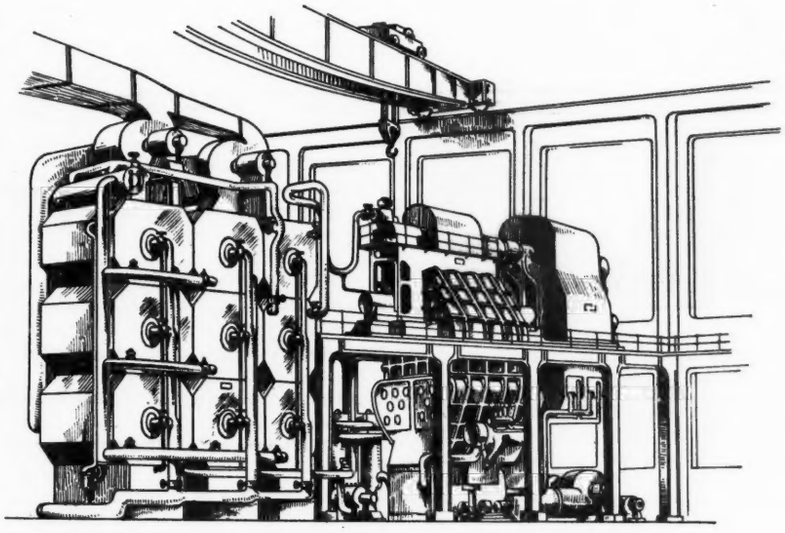
It has been demonstrated, Mr. Edwards pointed out, that the fuel consumed by a given installation is very closely proportional to the degree-days. It is thus possible to multiply the degree-days by the square feet of radiation, and, by an experience factor, to get the estimated fuel consumption.

As pointed out by Mr. Edwards, the introduction of natural gas in a community creates a strong competitive situation between those who sell gas and those who sell coal. Greater efficiency with gas is admitted, but coal and gas interests can rarely agree on the equivalent values. According to Mr. Edwards, one ton of 12,000 B.t.u. coal will, on the average, be equivalent to about 20,000 cu.ft. of 960-B.t.u. gas (it would be 25,000 with equal efficiencies). A poorly operated coal plant may bring this ratio down to 15,000, he said, and an efficient stoker-fired plant will raise it to 25,000.

The Memphis rate involves a demand charge based upon the maximum daily demand, which in the absence of tests is assumed to be 1/20 of the monthly consumption. In addition, there is a charge of 30 cents per thousand feet for the first one hundred thousand cubic feet, and 15 cents per thousand for all gas used per month in excess of this figure. The total net charge resulting varies from 43 cents per thousand to small consumers, down to as low as 17 cents for large. The domestic rate for gas for residential heating is practically 60 cents per thousand.

In conclusion, Mr. Edwards pointed out that in Memphis the cost of operation has proved gas to be comparable with coal, and materially lower than the average fuel oil. In many cases the gas costs have also proved to be lower than the previous season's operation with coal.

Some Day, Perhaps



"I AM INCLINED to believe," said George A. Orrok (see page 334), "that the boiler of the future might be termed a cellular boiler, in that it will be built of a number of unit cells, each cell using a certain amount of fuel and generating a certain amount of steam, the number of cells in the boiler depending upon the demand for steam. A boiler of this type would be self-contained with its auxiliaries, would make no dust or dirt, could be located in the same room as the turbine or generator, and the boiler room, as a boiler room, would disappear."

Slag-Tap Furnaces

IN A PAPER on slag-tap furnaces, A. L. Baker of Sargent & Lundy, Inc., presented some interesting facts on the design and operation of this type of furnace. His conclusions from this study was as follows:

1. The slag bottom boiler is undoubtedly in the process of major development at this time. It will require considerable time and further experimentation with designs and materials before all the facts required for a final analysis may be established.

2. Sufficient progress has been made, however, with the present installations to establish the following summary of advantages and disadvantages as they may be considered to exist today:

Advantages:

(*a*) A practical molten slag bottom can be installed at less first cost than a water-cooled hopper bottom.

(*b*) Any low-fusion-ash coal may be burned in pulverized form in an economical furnace using the molten-slag bottom.

(*c*) Any type burner may be used and turbulence of flame assisted by impingement on the molten bottom, if required, without damage to furnace or bottom.

(*d*) A saving in building height and cost may be obtained by using a lower setting. Very little headroom is required for handling the granulated slag.

(*e*) A simple and cleanly system of ash handling can be used.

(*f*) Dry dust collected from other parts of the boiler may be conveniently and automatically melted in the furnace bottom, thus eliminating duplication of ash handling in dry and molten form.

(*g*) Increased radiation absorption from the slag bed develops higher efficiencies from the exposed surfaces.

(*h*) Recent tests in one of the Chicago area stations seem to indicate that coarse coal may be burned readily with an appreciable saving in mill maintenance.

Disadvantages:

(*a*) Expansion movements of the furnace bottom materials cause wall troubles and slag leaks.

(*b*) A satisfactory and permanent seal between walls and bottom has not yet been developed.

(*c*) The high temperature existing in the vicinity of the lower generating tubes due to radiation from the slag bed causes fouling of these tubes, and, consequently, the boiler must be blown or hand-lanced more often.

(*d*) Low soot blower elements near the furnace must be protected from high temperatures.

3. A balancing of the preceding items from the designing engineers' viewpoint would indicate that the slag-tap furnace has certainly justified the efforts expended to date. Its development will proceed more rapidly with the present confidence existing in the correctness of its basic principles.

The Importance of Mixing In Burning Pulverized Coal

THE IMPORTANCE of continued agitation in the furnace for the effective combustion of pulverized coal was elaborated by Henry Kreisinger, consulting engineer, Combustion Engineering Corporation. His paper combined practical observations on the operation of various types of furnaces with a theoretical

study of the molecular actions in mixtures of various gases, and in gases containing suspended particles of burning pulverized coal. His paper stressed and amplified a fact already generally known, namely, that the burning of gases follows one law, while the combustion of suspended solid particles follows another.

No amount of preliminary mixing of pulverized fuel and air, said Mr. Kreisinger, can replace continual agitation in the furnace.

Among the systems he mentioned as producing this effect with fair effectiveness were opposed horizontal firing as applied at the Gilbert station of the New Jersey Power & Light Company, combination vertical and horizontal firing as applied in the East River plant of the New York Edison Company, and the tangential system of firing.

The system in use at the East River plant breaks up the jets from the vertical burners (firing downward) by streams of the mixture of air and coal from the horizontal burners. The impingement takes place close to the burners and results in quick ignition and intensive mixing. This method was recommended by Mr. Kreisinger as particularly applicable to the burning of anthracite and other low-volatile coals which are normally difficult to ignite.

He also spoke highly of the tangential method of firing, in which four sets of burners are placed in nearly the same horizontal plane, one set in each corner of the furnace. This method requires the use of a water wall, as refractory walls cannot stand the resulting erosion. It also somewhat complicates the piping for coal and air. On the other hand, he said, the extremely effective mixing produced, and the utilization of the full furnace volume, render possible higher rates of combustion per cubic foot.

Limitations on Heat Release

According to Mr. Kreisinger, the rate of heat liberation for refractory furnaces should not exceed 20,000 B.t.u. per cubic foot for continuous operation, or 15,000 B.t.u. if the ash is fusible. He said that the heat for water-cooled furnaces should not exceed 35,000 B.t.u., with a continuous liberation not exceeding 30,000 B.t.u.

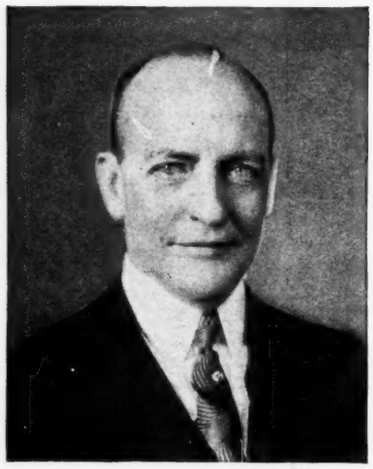
Higher rates of heat liberation, said Mr. Kreisinger, require finer pulverization. On the other hand, high-volatile coals do not warrant fine pulverization.

He pointed to the great variation in the combustible loss in flue dust, this ranging from 1 or 2 per cent with some of the sub-bituminous and lignite coals, to as high as 20 per cent with some low-volatile Eastern bituminous coals, and even 50 per cent with some anthracite.

Mr. Kreisinger reviewed the results of previous investigations of the burning of pulverized-coal particles. First, he said, the volatile matter is driven off and burned as a gas. When most of the volatile matter has been distilled and burned, the fixed carbon begins to burn.

The chief difficulty in burning the fixed carbon is getting oxygen to the particles through the blanket of inert gas that tends to surround it. Continued agitation is necessary to effect this.

Points brought out in the discussion of Mr. Kreisinger's paper were, that the shape of the furnace exerts a considerable influence; that if the combustion rate be kept reasonably low there will be time for burning of the combustible



GEO. F. GEBHARDT
Chairman Thursday afternoon

and sufficient cooling of the ash before it has had an opportunity to slag over the boiler tubes; and that the rate of reaction depends upon the concentration of oxygen.

Bituminous Byproducts

At a luncheon session on Thursday, A. C. Fieldner, of the United States Bureau of Mines, gave an interesting illustrated talk on "Recent Developments in Bituminous Coal Byproducts." One of his slides, covering coke production in this country for the last twenty-eight years, showed the shrinkage of the beehive ovens from a dominant place to an almost negligible factor in favor of byproduct ovens during that period, and especially during the last fifteen years. The production of gas-house coke has remained almost constant.

In the early days ammonia was the principal byproduct recovered; now it is gas. Per ton of byproduct coke produced in 1928 the average values of the accompanying byproducts were: Gas, $1.58; ammonia, $0.57; tar, $0.69; benzol, $0.60. The price of benzol has kept up because of its anti-knock qualities as a constituent of gasoline.

In the United States the majority of byproduct coke ovens are in connection with steel plants, whereas in Europe they are largely at the mines, with pipe lines distributing the gas to industry.

About 50 per cent of the tar produced in this country is used for fuel, but the speaker said that, in so far as he could discover, there had been no really successful commercial use yet found for low-temperature tar.

Pulverization and Boiler Performance

In a paper on pulverization and boiler performance, E. H. Tenney, chief engineer of power plants, Union Electric Light & Power Company, St. Louis, covered from a different angle some of the points discussed by H. Kreisinger in the morning session. His paper, however, gave somewhat more attention to economic factors.

"In a general way," said Mr. Tenney, "it seems to have been agreed that coarse pulverization results in unsatisfactory and incomplete combustion in the furnace, and that the finer the coal is ground the better the resulting furnace condition." Next he pointed out that few fundamental data are available on the effect of fineness. He outlined some of the points that should have especial consideration.

First, he pointed out, the coal must be sufficiently fine not to settle out in the supply pipe, or to clog any part of the supply system. In two respects, said Mr. Tenney, the fineness of pulverization affects the heating and ignition of the dust cloud. Finer grinding makes the dust cloud more opaque, and therefore increases the rate at which it absorbs radiant heat. Moreover, the thickness of particles being reduced, heat is conducted more rapidly to their interiors.

More important still, he said, is the effect of fineness on subsequent combustion. After the volatile has been driven off, subsequent combustion of the particle takes place entirely at the interface between the particle and the surrounding gases. Finer grinding increases this contact surface. This effect, he concluded, is probably the most important of any. Again, more perfect mixing is possible with the finer fuel.

The Economics of Fineness

Discussing the economic answer to the question, "What fineness is best?" Mr. Tenney distinguished between an existing plant and a proposed installation. Finer grinding permits greater heat releases per cubic foot. In a proposed installation, then, one may balance the cost of greater furnace volume against that of finer grinding.

In the plant already installed, said Mr. Tenney, the problem usually becomes one of balancing cost of coal preparation against saving in boiler efficiency. In some cases, however, it may be a matter of increasing fineness and preparation costs in order to increase boiler capacity, for finer coal, giving more rapid combustion, may permit higher furnace heat liberation. These may be limited by furnace wall construction.

Concluding his paper, Mr. Tenney presented the results of a series of tests made on a boiler in the Cahokia station. From the data obtained he plotted against the per cent passing through 200 mesh, as abscissa, the efficiency, the loss in flue dust and ashpit, and the

preparation cost. From these he was able to prepare a curve of net gain, showing, for the given installation in fuel, the most desirable fineness. These tests, he felt, suggested a general method by which the problem can be attacked in other plants.

In discussing Mr. Tenney's paper, R. M. Hardgrove suggested that measurement of flue-dust loss is a better guide to performance than efficiency. Henry Kreisinger discussed the length of time required for combustion of coals with different volatile contents, and showed that the higher the volatile content the less the fixed carbon in the flue dust. With lignite this may be as low as 2 per cent, with Pocohontas 15 per cent and with anthracite 50 per cent. After passing the temperature of ignition there is little use of increasing the temperature further.

Radiation in Boiler Furnaces

A NEW APPROACH to the problem of radiant heat absorption in boiler furnaces was presented by N. Artsay, mechanical engineer, assistant of George A. Orrok, New York City. He pointed to the confusion in this field, evidenced, for example, by differences in the evaluation of emitting surface, absorbing surfaces, coefficients of grayness, and in the ways of computing solid angles. So great has been this lack of agreement, he said, that designers have been forced to depend on rule of thumb and their own experience.

"The main trouble," according to Mr. Artsay, "is that the whole question of radiant heat exchange in boiler furnaces is not on the ignition side, but on the absorption side, to which so little attention has been paid so far, and this paper will endeavor to show that a good agreement with test results can be achieved on the assumption that the factor controlling radiant-heat exchange is on the absorption side." Developing this idea, he pictured an oil burner in open air on a clear, cold night, a certain continuous rate of combustion being maintained. Under such conditions the radiation emitted will be absorbed or dispersed in space. He next assumed this burner to be completely surrounded by a series of water-cooled screens at such distance that the total heat emitted by the burner would be unchanged. As these screens are moved closer, Mr. Artsey pointed out, the flame itself will be practically unaffected, until the approach to a certain distance, at which the radiant source will itself be affected. The combustion at this point, expressed in pounds of fuel per square foot of absorption surface, per hour, he called the critical rate of combustion.

Bringing the screens still closer, the temperature of the radiant particles will rise, and, according to the Stephan & Bolzman formula, the heat radiated (and that absorbed by the water wall) increases. The observed facts, however, indicate the reverse. From this line of reasoning Mr. Artsay concluded that in boiler furnaces of ordinary dimensions the controlling factor is the receiving surface rather than the radiating surface. Starting from that assumption, he developed a series of formulas which, he showed by a curve, closely check actual results measured in various boiler plants.

The only discussion of Mr. Artsay's paper was by Prof. W. J. Wohlenberg, who sharply criticized some of the authors formulas. Mr. Orrok, who presented Mr. Artsay's paper, defended these formulas to the extent that they are empirical and are sufficiently close for most practical purposes, whereas Professor Wohlenberg, he believed, was insisting on rational expressions only.

That part of Mr. Orrok's paper that elicited the most discussion was his reference to smokeless fuel. F. H. Rosencrantz told of the agitation in England against the discharge of sulphurous fumes from power plant stacks which has finally led up to the extensive investigations for the Battersea Station (see *Power*, Nov. 4 and Dec. 30, 1930).

"The Situation in England is accentuated," he said, "by the fact that the stacks are generally low."

Dr. Tunney, of the Chicago Health Department, then arose to discuss the effect of smoke on ultra-violet ray penetration. Studies are now being conducted by the University of Chicago to determine the effect of such loss of the sun's rays on the health and development of children. Investigations of some of the natural-gas-burning regions in the Southwest show practically no difference between the intensity of ultra-violet rays in the cities and in the surrounding country, whereas in Chicago the surprisingly long season of low ultra-violet ray penetration has been definitely traced to smoke.

Unaccounted Losses in Boiler Tests

IN A SEARCH for the causes of high unaccounted losses in boiler tests, the Brooklyn Edison Company, Brooklyn, N. Y., has conducted an elaborate research, emphasizing particularly the loss in unburned hydrocarbons. This work, as described in a paper by W. F. Davidson, director of research, Brooklyn Edison Company, involved extremely refined methods of sampling and testing gases. Results obtained are still inconclusive, so that further research is in prospect.

Elaborate precautions were taken to secure true samples of flue gases and to mix them completely before analysis.

In the analysis itself, carbon dioxide was first absorbed. After this, the gases were subjected to a complete catalytic combustion in the presence of oxygen, after which the carbon dioxide was again determined. From this and other data the heat value of the hydrocarbon present was computed.

It was not possible to combine these laboratory experiments with boiler tests in which all of the details were carried out in accordance with the test code. The work done has been sufficient, however, in the opinion of Mr. Davidson, to indicate that the presence of unburned hydrocarbon affords only a part explanation of the high values of radiation and unaccounted-for losses previously observed. It was also found that the carbon monoxide, as determined in the laboratory, failed by a wide margin to check that found by skilled observers in the field. The chief conclusion was that further research is needed.

"In spite of somewhat formidable obstacles," Mr. Davidson concluded, "the colorimetric method holds out several attractive features. It will give results in terms of heat, which is of most interest to us, without the necessity of making involved calculations which may be based on more or less uncertain assumptions. It will eliminate the necessity for making separate determinations of the several components, and a smaller sample may suffice."

Power Pioneering

AN INTERESTING economic philosophy of pioneering, as it applies in the power field, and particularly in the selection of boiler equipment, was presented by F. H. Rosencrants of the Combustion Engineering Corporation.

At the outset he stressed the necessity of clear understanding, active co-operation and equitable division of financial responsibility between the manufacturer and the user in the commercial application of new developments. For such co-operation, he pointed out, the central stations of interconnected systems are much better placed than the industrial plant. In the latter the value of possible fuel saving does not generally warrant any radical departure from established and tested practice.

On the other hand, Mr. Rosencrants said, central stations which are a part of great systems may properly be used to try out new units. In case of failure other units on the system can carry the load. The lessons learned from such experiments can be applied in a way that will yield a very substantial saving in fuel.

Mr. Rosencrants spoke highly of the courage and initiative of designing and operating organizations in the power field. Among the developments of the twelve years since the war he listed pulverized-fuel firing, air preheating, feed-water heating by extracted steam, water-cooled furnaces and the high-pressure reheat cycle. With these has gone a rapid increase in the capacity of boiler units, as well as a rapid increase in steam pressure and temperature. Associated design problems in connection with stoker equipment, forced- and induced-draft fans, ash handling, flue

dust separation, superheaters, piping systems, boiler feed pumps, etc., have been attacked with great success.

The human tendency to "soft pedal" the weak points of new systems has its advantages, according to Mr. Rosencrants. He said that the present development of pulverized-fuel firing might never have taken place if the early difficulties with slagging, refractory erosion, drying, dust elimination, condensation troubles, etc., had been fully aired at the start. As a consequence of the early enthusiasm, he added, pulverized fuel firing has passed over the pinnacle of complications in design, and has rapidly bcome a comparatively simplified product of today.

He referred to the present interest in high-pressure reheat cycle, and the Loefler high-pressure high-temperature cycle.

The next trend, in the opinion of Mr. Rosencrants, will be toward higher temperatures with moderate pressures. When the possibilities of pressure, temperature and vacuum are exhausted, he predicted a keener interest in the binary vapor cycles, such as the mercury-steam cycle and the combination binary-chemical cycle of Dr. Koenemann. Binary cycles, he felt, open a vast field for the power engineer, and it is impossible to predict the variety of forms in which they may ultimately appear.

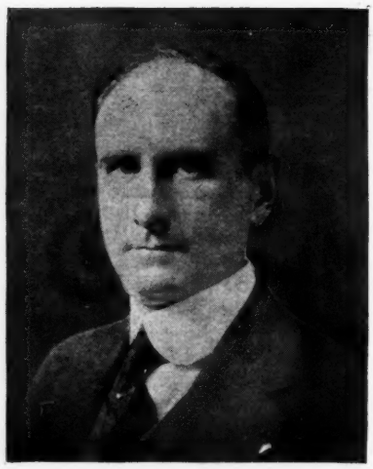
The Boiler Room Of the Future

IN A MOST interesting paper, combining prophecy with a dramatic review of boiler plant history from the days of Newcomen, George A. Orrok, consulting engineer, New York City, envisioned a day when no solid fuels will be burned under steam boilers. His prediction was that all coals will be gasified at the mines, or at other points away from congested centers, and then piped to industrial regions for combustion without dust or other atmospheric pollution.

Reviewing the early developments in boilers, Mr. Orrok traced the evolution of the tea kettle boiler of Newcomen, and the wagon box boiler of Watt into the internally fired Cornish or Lancashire boilers in England, and the return-tubular boilers in America. He pictured the "large" American boiler plant of former days, with sweating firemen hauling coal to fifty or more small tubular boilers and trucking away the ash, under conditions of dirt and heat.

Then came the enlargement of water-tube boilers, mechanical stokers, the firing of coal in pulverized form, better working conditions, ash hoppers and ash-disposal machinery, forced- and balanced-draft systems.

The discovery of oil in Pennsylvania, as Mr. Orrok pointed out, led to its use in boiler rooms, along with natural gas, and revealed new possibilities of cleanliness and convenience.



A. A. POTTER
Chairman Friday morning

Today the boiler room is a reasonably clean, cool, comfortable building, housing the entire steam-generating apparatus, with plenty of light and with automatic control. The boiler operator has become an overseer, whether the fuel be coal, oil or gas.

Meanwhile, says Mr. Orrok, boiler efficiencies have increased from 50 to as high as 96 per cent. Safety has enormously increased; disastrous boiler explosions practically never occur with modern water-tube boliers.

Our present use of fuel, said Mr. Orrok, is equivalent to 25×10^{15} B.t.u. a year, of which approximately 65 per cent represents solid fuel. He stressed atmospheric pollution, particularly from the ash content of solid fuels, as a primary factor favoring gasification. This ash content is constantly increasing as users turn to lower-grade fuel.

With no dust catchers, said Mr. Orrok, it is probable that between 2 and 4 per cent of the weight of the coal fired is distributed in the vicinity of the plant as dust. Some of the smoke commissions in Great Britain have reported deposits exceeding one thousand tons per square mile per year in certain cases—"a most serious handicap to any locality."

Public authorities, Mr. Orrok felt, will bring increasing pressure to bear on those who create such nuisances, and this pressure, in turn, will hasten the day when solid fuel will be gasified at a distance from the point of its application to steam boilers.

He cited the rapid growth of pipe lines for natural gas (more than 200,000 miles of 6-in. or larger already in service) as a development that will hasten the day when manufactured gas will be transported to distant points. He looked upon petroleum and its products as the resource whose use will some day be confined mainly to automotive and similar applications. He predicted that the household boiler of the future will be gas-fired.

With the general adoption of gas-firing under power boilers, Mr. Orrok felt that boilers themselves, and furnaces, will undergo rapid changes in design, and that the boiler room as a separate compartment of the plant may disappear. "With gaseous fuel and the preheating of combustion air, the flame can be made exceedingly short and the heat liberation may be quite large. The combustion space, which today is of considerable size, will be much reduced, and the speed of the products of combustion through the boiler will be very high, in order that the heat transfer may also be high. I am inclined to believe that the boiler of the future might be termed a cellular boiler, in that it will be built up of a number of unit cells, each cell using a certain amount of fuel and generating a certain amount of steam, the number of cells in the boiler depending on the demand for steam. A boiler of this type would be self-contained with its auxiliaries, would make no dust or dirt, could be located in the same room as the turbine and generator, and the boiler room, as a boiler room, would disappear."

Missouri-Kansas Coals

A PAPER by E. L. McDonald, efficiency engineer, Kansas City Power & Light Co., showed how the quality of average shipments of Missouri-Kansas coals has been greatly improved in recent years. Mr. McDonald also recounted the development of boiler settings and underfeed stokers to burn these coals, and showed the resulting gain from this combined improvement.

The chief reason given by Mr. McDonald for the marked improvement in coal delivered has been the selling of coal on a B.t.u. basis. On this basis of selling, the coal operator pays the freight on all of the moisture and impurities, and receives nothing in return. The resulting pressure has brought about an improvement equivalent to from 300 to 1,000 B.t.u. per pound as received. Incidentally, the better coal reduces operating trouble.

Mr. McDonald's paper showed the evolution of chain-grate stokers and settings for these coals from 1905 to 1930. Starting with very low settings and natural draft, the furnace and stoker have evolved into modern high-set units supplied with preheated air and forced draft and equipped with water walls. The quicker ignition created by preheated air has permitted the utilization of a greater portion of the grate for fuel-burning, and has resulted in higher combustion rates and higher capacities.

After experiments with various kinds of refractory materials, the water-cooled side wall has proved most successful in the elimination of side wall clinkers and maintenance.

Stoker speeds have increased from 20 to 65 and 70 ft. per hour, permitting faster pick-up, thinner fires and more protection for the rear of the stoker. The fuel-burning rate has increased to 48 lb. per square foot average and 65 lb. maximum.

Smoke Abatement Progress Is Discussed

Final session of fuel meetings devoted to discussion of atmospheric pollution by smoke, fly ash and sulphur gases. Round-table speakers bring out practical difficulties and point way to their solution

Marked Interest Shown in Smoke Abatement and Fly Ash

OF ALL THE Fuels Meeting sessions none evoked keener interest than that on smoke abatement, Friday afternoon. The one written paper, "The Fly Ash Problem," by H. N. Bubar, was followed by a number of ten-minute talks on various phases of smoke abatement and atmospheric pollution, after which the Chairman, John Hunter, of St. Louis, threw the meeting open for a general discussion, which continued until the closing hour of 5. It was significant that nearly all of the 200 present remained until the end.

Mr. Bubar estimated that in the average pulverized-coal installation about 70 per cent of the total ash in the coal goes up the stack. Of this probably more than 85 per cent will pass through a 300-mesh screen. Of the remaining 15 per cent, about 1.5 per cent will be retained on a 100-mesh screen and 4.5 per cent on a 200-mesh screen. Expressed in microns $\left(\frac{1}{1{,}000}\text{ mm.}\right)$, more than 50 per cent of the dust is less than 20 microns in diameter and 27 per cent less than 10 microns. A dust particle 25 microns in diameter, when elevated 200 feet, will travel 16 miles in a 10-mile per hour breeze and one of 12 microns will travel 65 miles.

WHAT HAPPENS TO DUST CLOUDS

Furthermore, where a stack is equipped with dust collectors that remove all of the coarse particles and a large part of the fines, the dust cloud will be observed to rise until it has passed the limits of vision. This is in contrast to a stack not so equipped, which will reveal rapid expansion of the dust cloud, with one portion settling to the ground, a second portion carrying in a horizontal direction and the remainder rising until out of vision.

On this premise the author contended that the finer particles of fly ash, those of 12 microns and less, cannot be considered as constituting a dust nuisance. Expressed differently, it would appear that removal of all those dust particles retained on a 300-mesh screen and a large percentage of those passing a 300-mesh would eliminate the possibility of an actual dust nuisance.

Before the problem can be solved it is essential that all parties concerned have a mutual understanding of just what constitutes a nuisance. While conceding that efficiencies higher than 80 per cent are attainable, Mr. Bubar questioned whether higher efficiencies are necessary when taking into consideration the bulk and cost of the necessary apparatus.

In discussing Mr. Bubar's paper, J. C. Hardigg, of New York, emphasized as the three most important points of the problem, first, an accurate and accepted method of sampling solids in the gas stream; second, determination of sizes in the sample; and, third, agreement as to what degree of atmospheric pollution by dust shall be permissible. He suggested further that it might be preferable for codes to specify permissible fly ash as a percentage of the coal burned rather than in grains per cubic foot of flue gas, as the two would be quite different, depending upon the excess air.

A JOB FOR ENGINEERS

The first of the ten-minute talks was by Ely C. Hutchinson. Pointing out the present smoke abatement situation in the United States, Mr. Hutchinson said that the public would demand through the courts the elimination of the nuisance and the right to breathe an unpolluted atmosphere, whether in the country or centers of industry. He referred to hundreds of thousands of dollars spent by large power producers in research and in the development of plants for the control and abatement of the nuisance from combustion fumes at their plants.

ELY C. HUTCHINSON insisted that smoke and fly ash abatement are the engineer's work—"cannot be solved by medical clinics."

Mr. Hutchinson urged greater publicity for this work to forestall unadvised action by the politicians and others who make a business of rising to power by attacking the so-called "vested interests."

"Lastly, but by no means of least importance," he said, "I am fully convinced that smoke and fly ash abatement is engineer's work and it cannot be solved by medical clinics. Without question, the public health is very much concerned, and to the extent necessary to include this element the doctors are needed. The actual administration and execution of smoke abatement ordinances is, however, solely the work of experienced engineers. No greater work can be done by the American Society of Mechanical Engineers, and certainly none of more importance, than to accept the responsibility for the intelligent and co-operative guidance of this whole smoke and fly ash abatement problem in the interests of the people and in the interests of a square deal for the power producers."

Mr. Hutchinson reviewed smoke abatement progress in Europe, particularly the experiments of the London Power Company.

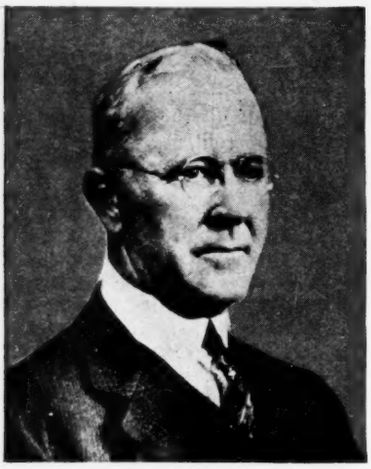
EUROPE HAS MADE PROGRESS

"The City of London," he said, "is going at this whole problem scientifically. It has a department of Scientific and Industrial Research with a subsidiary Atmospheric Pollution Research Committee. It is developing methods of regulation, standards for the measurement of smoke and fume density, and it is said that a simple device has recently been perfected that will very quickly determine the sulphur content in gases.

"In Germany studies and research have been going on for several years

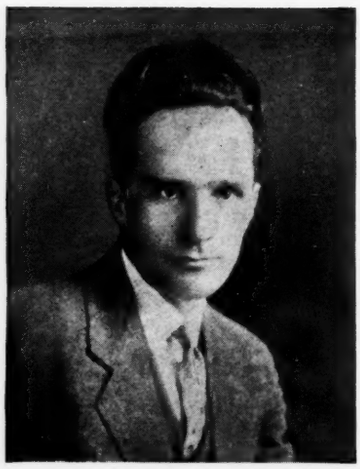
past with respect to the elimination of flue dust. With characteristic thoroughness the Germans are examining into all the available processes throughout the world, and last summer had a man in the United States studying the progress in this country. Some of the German reports are available, but a great deal more is to come."

Colonel C. H. Whitlock, director of smoke abatement research at Stevens Institute, discussed ordinances. "Many existing smoke ordinances in the United States," he said, "date back to 1901 or 1902, and some of these have since remained unchanged." The ideal ordinance should be broad and kept distinct from the rules and regulations, which can then be drawn up by the advisory board. This makes flexibility to suit changing conditions without the delay and inconvenience incident to amended legislation. The ordinance should provide that the head of the smoke department be a professional engineer of recognized qualifications and that the advisory board be also so constituted, in part at least. This is important not alone because smoke abatement is essentially an engineering problem, but also because politicians have respect for the opinion of engineers. Inclusion of the Ringlemann chart in an ordinance is usually advisable, as this, being recognized by the United States Bureau of Mines, is always accepted by the courts as a standard method of comparison.



COLONEL C. H. WHITLOCK warned against incumbering smoke ordinances with detailed rules and regulations.

Victor J. Azbe, of St. Louis, expressed the opinion that practically all smoke ordinances are too lenient in that they permit No. 1 and No. 2 smoke to be emitted continuously and No. 3 for short periods, and make no reference to domestic smoke. If all offenders were made to obey the laws strictly as they now stand, the effect would be hardly noticeable. He would strive for "smoke elimination" rather than abatement, by not permitting the use of soft coal save by expert operators, prohibiting hand firing, and making it obligatory in domestic furnaces to use smokeless fuel, down draft or underfeed stokers.



VICTOR AZBE advocated complete smoke elimination rather than abatement.

Dr. O. P. Hood, mechanical engineer of the United States Bureau of Mines, observed that this bureau seems to be in a position to feel the pulse of the country in matters of this kind. As an indication of the present awakened interest in smoke abatement, he said that it had taken the Bureau five or six years to dispose of 500 copies of the model smoke ordinance compiled jointly by the A.S.M.E. and the Bureau of Mines in 1924, whereas 1,700 reprints that were made late in 1929 had been exhausted in nine months.

He urged that such standards as might be prescribed for furnace heights and settings refer not to localities but solely to the fuel used.

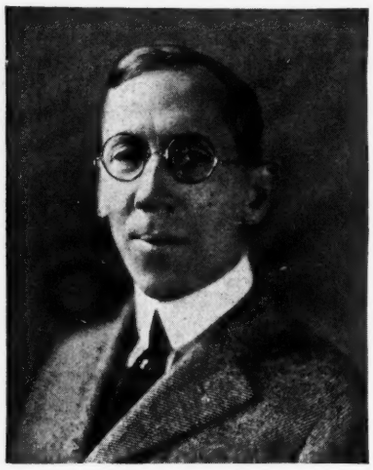
Progress in New Jersey and Massachusetts

W. G. Christy, who heads up the recently formed smoke department for Hudson County, N. J., referred to the inadequacy of individual municipal ordinances in many localities where a whole metropolitan area is involved. Hudson County is the first such subdivision to adopt an ordinance, although in Massachusetts a state law has been adopted and at present takes in 29 other cities and towns. He urged the basing of smoke abatement campaigns on engineering programs, stressing the economic side and thereby securing cooperation. Every means of attaining and maintaining publicity should be employed, as this is most essential in securing sustained appropriations to carry on the work.

David A. Chapman, director of smoke abatement for the Commonwealth of Massachusetts, discussed the new law in Massachusetts, which requires submission of all plans and specifications as to settings, etc. Under present conditions of unemployment and business depression, the problems of enforcement have sometimes become difficult where extra expense is involved. Heavy oil is not permitted to be burned under low-pressure heating boilers that do not have expert attendance. However, the public, and especially the women's clubs in Massachusetts, are actively behind the new law.

A. J. German, chief engineer, Scovill Manufacturing Company, told of his experience with a number of dust catchers which his company had installed after receiving complaints from near-by residences. At first, although there were evidences of the catchers having functioned, practically no dust was recoverable and the complaints continued. Further investigation developed that the connections had been so made that the accumulated dust was all drawn up through the chimney whenever the clean-out door was opened. A change in duct arrangement and providing a tight valve on the dust-discharge pipe rectified the trouble.

Other speakers were H. B. Meller, of Pittsburgh, who pointed out that legislation must follow, not precede, development; P. E. Mohn, who criticised the down-draft furnace advocated by Mr. Azbe; H. K. Kugal, of Cleveland; and J. C. McCabe, of Detroit.



H. B. MELLER declared that legislation must follow, not precede, development.

A last-minute paper, "Accuracy of Weighing and Analyzing Coal," by F. W. Martin and E. Mandel, of Chicago, was added to the fuels program after the latter had been printed. This paper was based on comparative tests of over 500 samples collected for a month at the Calumet, State Line, Waukegan, Powerton and Crawford Avenue stations.

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Power Costs in Hotels—In publishing an abstract (*Power*, February 17, 1931) of the article "Heat, Light and Power Costs in New York City Hotels," by Edward C. Romine, the following credit line was inadvertently used, "Paper made available by Standard Statistics Company, Inc." Actually Standard Statistics had no connection with the presentation or release of this paper.

Photo by Kaufman & Fabry

Combustion Equipment Prominent At Fifth Chicago Power Show

WITH the products of more than 200 of the leading manufacturers occupying practically the entire floor space of the Coliseum, the Fifth Midwest Power Show, held at Chicago, Feb. 10 to 14, had much of interest to the power plant engineer. Although the show probably did not measure up to some of its predecessors, owing to the absence of some of the larger manufacturers, to one who was interested in gathering new ideas, finding means of better utilizing his present equipment or locating some accessory that would help to eliminate waste and make his plant more economical, the Fifth Power Show proved of value.

Held in conjunction with the Fifth Midwest Power Conference and the Fourth Fuels Meeting, the recent show was the first to be held in Chicago since the adoption of the alternate year plan. Under this plan, future shows will be held in Chicago during the month of February of the odd years 1933, 1935, etc., and in New York in December of the even years 1932, 1934, etc. This plan, it is expected, once it is thoroughly established, will do much to improve the quality of the shows and enhance their value to the engineer in general.

As was to be expected, many of the exhibits were more or less duplicates of those shown at New York last December, but owing to the small overlapping in the attendance at the two shows, this would seem to be of little significance.

Most of the new equipment found at the show was described during the last year in the "What's New in Plant Equipment" section of *Power* and reviewed in the Feb. 10 number.

Probably the most notable feature of the recent exposition was the large showing of mechanical stokers, in sizes ranging from those suitable for the smaller heating boilers up to units capable of burning 3,000 lb. of coal an hour. Most of the units shown were designed especially for burning Illinois and Indiana coals.

Small Chain-Grate Stoker

ONE OF THE larger manufacturers of chain-grate stokers introduced a small unit suitable for boilers ranging from 1,000 to 2,500 sq.ft. of heating surface. This unit is made in widths from 1 ft. to 4 ft. 6 in., and has an overall height from top to bottom of chain strands of 14 in. making it suitable for installation under low-set boilers. Another manufacturer showed an improved underfeed unit equipped with agitated feed hopper to prevent arching of the coal, and with laterally moving tuyères for agitating the fuel bed.

Although most of the units shown were motor-driven through a selective gear transmission, and with direct-connected forced-draft fan, three were hydraulically operated with a wide range of feed control and an independent motor-driven forced-draft fan.

To provide a wider range of control and give more

flexibility in the operation of the small stoker than is usually afforded by the standard drive, one manufacturer has developed a feed regulator applicable to practically any type of unit stoker and suitable for controlling two or more stokers independently of each other. The mechanism consists of a fractional horsepower motor, which drives a spiral cam through a large gear reduction so that it revolves once in approximately two minutes. The cam, in turn, operates by means of contact shoes, one or more mercury switches connected in the stoker motor circuits. The contact shoes can be set anywhere along the cam to vary the interval from entirely off to continuous running.

Boiler Tests Run Daily

ONE OF THE most popular exhibits was that of a model heating plant in actual operation. This combination of boiler, stoker and measuring instruments was set up to show typical operation of a low-pressure heating plant using representative low-priced coal most easily obtainable in the Chicago territory. The steam output of the boiler, which had a rated capacity of 11,670 sq.ft. of radiation, was discharged to the heating mains of the Coliseum. The unit was fired by an overfeed stoker and was equipped with all the indicating and recording instruments necessary for economical operation. Additional accessories included a smoke indicator, remote liquid-level gage and draft regulator. Daily during the show an eight-hour test was conducted on the unit, a different kind of coal being used each day. A typical day's result showed a combined boiler and furnace efficiency of 74.5 per cent, an average CO_2 of 11.3 and an exit gas temperature around 500 degrees.

Although the showing of pulverized-coal equipment was not so extensive as that of stokers, this equipment was fairly well represented. One manufacturer, in addition to showing an improved grinding element of a type of pulverizer now available in capacities up to 40 tons an hour, exhibited a large-sized drawing of a two-ton mill now being developed especially for direct firing and to operate with air pressure on the mill instead of suction, as is the usual practice. Another manufacturer had on display for the first time a three-ton roller mill of the same general design as the larger-capacity pulverizer built for some years except that only three grinding rolls are used, instead of four or more as in the larger units. A third manufacturer included in his exhibit a newly designed cyclone burner in which the coal and primary air are discharged into the central chamber of the burner through a series of small tangential slots so directed as to give high turbulence and thorough mixing. Secondary air is admitted through louvered openings directly behind the coal and primary air jets.

The exhibits of boilers and allied equipments, such as superheaters, economizers, and air heaters, were comparatively few. With the exception of three or four firebox boilers for heating services, the displays of this equipment were confined to sectional headers, hot-processed drum heads and samples of electric fusion-welded drums. These drums had been tested beyond the elastic limit and permanently distorted without any sign of failure in the weld. Samples of chromium alloy castings and steel alloy seamless tubes were also included.

As at former shows, evidence of the fact that power engineers are concerned with heating was to be found in the variety of heating equipment shown. Two types of differential-vacuum heating systems were shown in actual operation. A new type of radiator valve was introduced. In place of the conventional type of packing, two Monel metal disks and two stainless steel disks are utilized. These disks, which are clamped in place by the bonnet nut, are made to seal against a collar on the stem, giving a ground joint which is claimed to be tight against pressure or vacuum.

An innovation in heating equipment was a concealed type of radiator constructed of seamless drawn copper tubes each of which is connected to the headers with a screwed ground joint. The radiating fin is a continuous spiral metallically attached to the tube. The casing of the radiator, which is adjustable for height, is completely concealed within the wall and provided with an aluminum grille top and bottom. An important feature of the unit is accessibility. By removing the lower grille and disconnecting the steam pipes, the complete heating element is readily removed as a unit.

A complete line of portable electric unit heaters was shown for the first time. This type of heater is particularly applicable for heating isolated buildings, for intermittent heating needs and for off-season heating. Other heating exhibits included a line of condensate pumps and receivers, zone heating controls and electric temperature control systems.

A recent development in air-filtering equipment introduced at the show was a dry fabric filter the feature of which is an extensive area (36 sq.ft.) of filtering material in compact form. The unit consists of a frame supporting 24 screen panels. The panels act as separators between the folds of the fabric in such a way that air must pass through the fabric. The ease with which the fabric can be removed and a new one inserted from a supply roll is a feature.

Improved Speed-Transmission

IN MECHANICAL transmission equipment the most recent developments found at the show were a positive infinitely variable speed transmission, a motorized speed reducer and a variable-speed transmission equipped with a system of remote control. The first unit is similar in general construction to the standard speed transmission employing a flexible wedge-shaped chain runing between cone-shaped disks, except that radial teeth are cut in the conical faces of the disks, and self-adjusting teeth projecting beyond the sides of the chain are arranged to engage the radial teeth of the disk and give positive transmission. In the motorized unit a speed reducer and a motor are combined to form a compact totally inclosed unit. The remotely controlled speed transmission has been developed to make possible accurate synchronizing of a series of machines or section of a machine automatically. The control embodies a specially designed two-way mercury switch and a solenoid brake to stop the speed-adjusting motor. Numerous exhibits of ball and roller bearings with various types of oil seals were included.

Two diesel engines, a six-cylinder 210-hp. stationary unit and a 33-kw. three-cylinder diesel generating set were important prime movers at the show. Both engines were of the four-stroke-cycle type arranged for mechanical injection of the fuel directly into the engine cylinder. Average compression pressure on the unit is given as

400 lb., with a firing pressure not exceeding 600 lb. Removable cylinder liners and copper-aluminum alloy pistons are used.

Pumps were fairly well represented. The most recent development in this line was a centrifugal condensate pump of the two-stage type. The first stage is in the center and discharges right and left to single suction impellers forming the second stage. Full discharge pressure is obtained on the stuffing boxes to insure against air leakage. Hydraulic balance of the rotor is also obtained.

The usual number of regulators and controllers was shown. These included a new boiler feed pump governor designed primarily for use with turbine driven pumps; special turbine bleeder valves with oil closing trip arrangement, feed-water regulator for return-tubular and Scotch Marine boilers; complete desuperheating and reducing station; and a Bourdon tube pilot control for use in the process field.

Instruments for High Pressures

THAT the instrument manufacturers are keeping pace with the demands imposed by the higher pressure and temperatures now being employed was evidenced by the new instruments at the show. These included indicating gage for pressures up to 5,000 lb. equipped with a Bourdon tube bored out of a special steel alloy designed to give uniform expansion and contraction throughout the entire range of the gage; an alloy helical steel movement for recording gages, of one-piece tubing, all-steel and all-welded; flow-meter bodies for pressures up to 5,000 lb. of heavy seamless open hearth tubing with flanges and top caps made from solid blocks of steel. Other new instruments included a control pyrometer equipped with a mercury contactor switch, having a current-carrying capacity of 50 amps. at 220 volts; a per cent leakage conductivity recorder, a smoke recorder for continuously measuring and recording the density of smoke; and a concentration indicator for boiler water, designed to show the boiler concentration directly in grains per United States gallon.

The exhibits of piping and valves were confined principally to valves in sizes below 8 in. New designs of lubricated quarter-turn cocks, and gate valves for pressure up to 1,500 lb. were important items. Two companies showed the DeFlorez system for controlling valves from a remote point. With this system the actual work of opening and closing the valve is done by the operator, the power being transmitted between the two points by Selsyn motors.

Of particular interest to those concerned with the fabrication of piping systems by means of welding was a pipe-cutting machine that cuts openings in pipe and shapes the end of the branch to fit the opening in one operation. The machine, which has a floating and rotating arbor with an oxy-acetylene cutting torch mounted on each end, automatically prepares pipe of 3 to 18 in. diameter of any wall thickness for fabrication into welded tees, miter elbows, and bull plugs. In addition it will bevel plain end pipe for butt welds. The bevel made with the machine, according to the manufacturer, conforms to the standards of the American Gas Association and the Heating and Piping Contractors National Association.

Refractories and water-cooled furnace walls of the bare and armored types were fairly well represented, as also were insulation materials for heat and cold.

In conclusion, it might be added that the exhibits as a whole were of high quality and attractively arranged and the attendance both in number and responsiveness was reported to compare favorably with other shows.

Photo by Kaufmann & Fabry

View of the exposition from the north balcony of the Coliseum, where the products of more than 200 manufacturers occupied practically the entire floor space

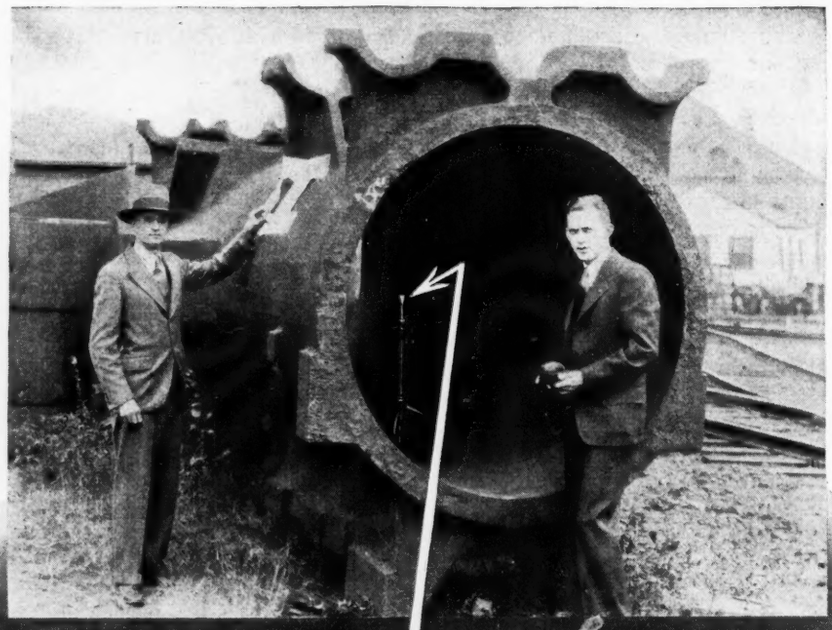

Fig. 1 — Gamma rays from capsule pass through steel to film outside

Gamma rays produced by radium or radium emanation penetrate heavy steel machine parts and register flaws on photographic films. For metal thicknesses greater than 2 or 3 in. this ray source has certain commercial advantages over the X-ray

▼

GAMMA RAYS in the POWER FIELD

By Robert F. Mehl, Ph.D.
and Charles S. Barrett, Ph.D.

Superintendent and Assistant Physicist, respectively, Division of Physical Metallurgy, Naval Research Laboratory, Washington, D. C.

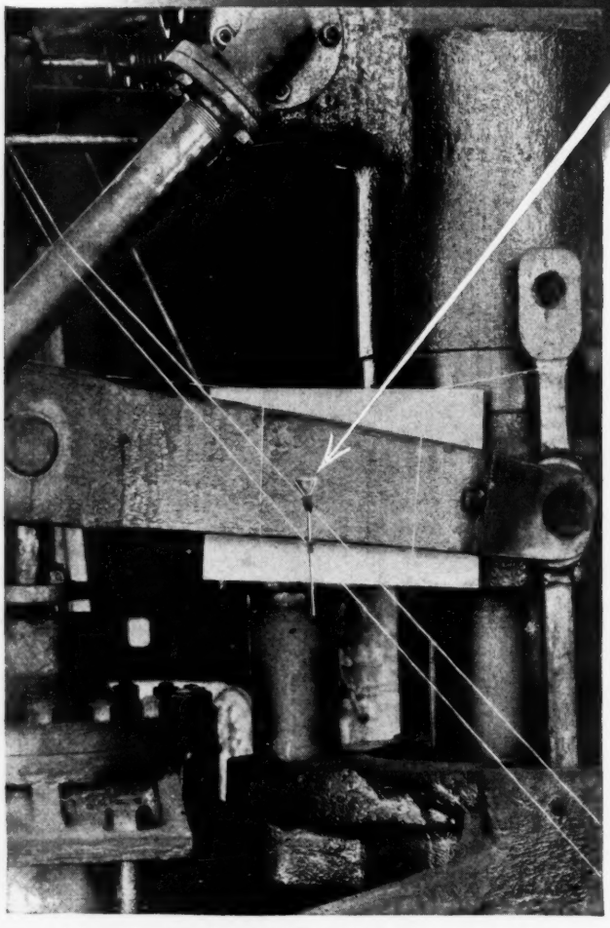

Fig. 2—Radium or radium emanation is supported in thistle tube before press arm. Film is behind

THE USE of X-rays for taking shadow pictures of metallurgical and other materials has, during the last fifteen years, been made the subject of many articles in various scientific journals. It is now admitted that radiography by the use of X-rays is very serviceable in the detection and location of defects in steel castings, welds, etc. Industry is increasingly adopting the method.

There is, however, another radiation which is of value for radiography, namely, the gamma rays emitted by radioactive substances. They are rays much more penetrative than ordinary X-rays. Gamma rays from radium or radon (radium emanation) are as penetrating as X-rays from tubes operating at one or two million volts. (Ordinary X-rays used industrially require 100,000 to 220,000 volts.)

High-voltage X-ray tubes are now being developed in various physics laboratories, but are not yet commercially available. When and if they do become so the expense

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of a tube and the high voltage electrical equipment to operate it will be great. The equipment will not be readily portable. A source of gamma rays is, however, absolutely portable, consisting simply of a small metal capsule about the size of a .22-caliber cartridge containing a radioactive element.

To make radiographs, this capsule is supported on a simple stand in front of the object to be tested, and ordinary X-ray film, in a suitable light-tight container, is fastened on the opposite side of the object. Defects such as cracks, holes, foreign matter, etc., cast their shadows on the film and are readily recognized upon its development.

By this method radiographs have been taken through thickness of steel far beyond the practical limit of X-rays. Very few X-ray radiographs have been taken through more than 3½ in. of steel; the X-ray limit may be put at 3½ to 4½ in. Radiographs by the use of gamma rays have been taken through 6, 8 and 10 in. of steel. (cf. Mehl, Doan, and Barrett, Preprint 32, *American Society of Steel Treating,* September, 1930).

The rays from radium, while capable of such great penetration are, nevertheless, able to produce good radiographs through thin sections also, say ½ in. to 2 in. (cf. previous reference, also Barrett, Gezelius and Mehl, *Metals and Alloys,* December, 1930). While they do not yield the "contrast" found on X-ray radiographs, their sensitivity to defects is ample for practical use.

Steam power plants are now operating at higher and higher pressures and requiring correspondingly heavier castings throughout. The damage that could be caused by one of the castings breaking under the pressure is terrific. It is quite common practice to subject castings in such an installation to radiographic examination. Since the thickness that must be penetrated is never much below the limit of usefulness of the X-ray, and now frequently beyond, the gamma-ray method can be of great usefulness for this purpose.

Any radiographic job requiring portability finds the gamma ray a ready tool. It can be carried to the top of a tall building, to the bottom of a mine, to the interior of a complicated steel network, or even under water.

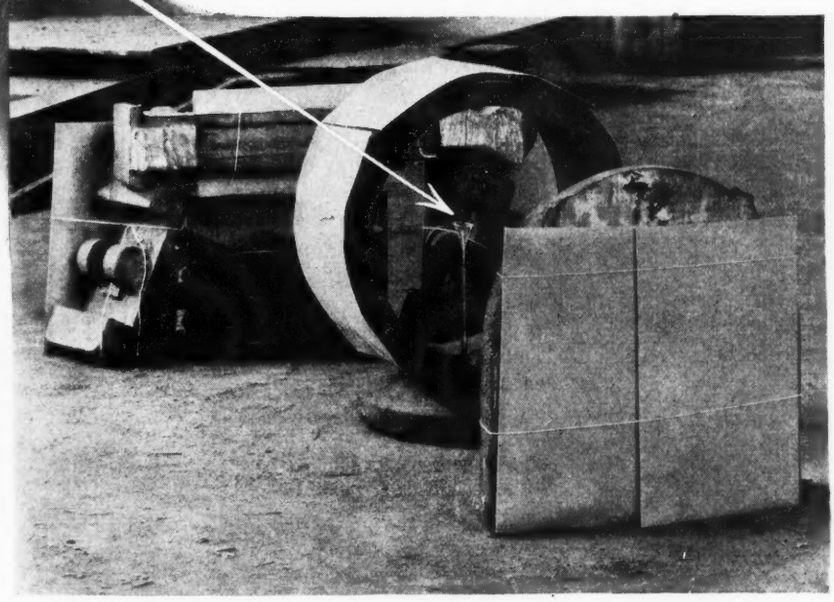


Fig. 3—Gamma rays, radiating in all directions, can be used to radiograph many castings simultaneously

It is too early to give data on the cost of inspection by this method. Radium need not be bought for the purpose, for radium or radium emanation may be rented from hospitals or radium supply houses, carried to the scene of operations, used in the exposure, and returned at the conclusion of the exposure.

It is an important feature of this method that many specimens may be arranged around the gamma-ray source, for the radium emanation emits gamma rays in all directions, that is, spherically. In appraising the cost of such a method of inspection this feature must be remembered.

Exposure times depend upon the intensity of the rays used, i.e., upon the amount of radioactive material, upon the thickness of the specimens, upon the distance of the specimens and film from the source of rays, and upon the method of handling the film. An exact knowledge of the effect of all these factors has been obtained (cf. *Metals and Alloys* article), so there need be no guesswork in making proper exposures.

In the use of gamma rays, as in the use of X-rays, protection must be given the operator against the harmful effects of the rays. Distance, of course, is the best protection, and since no attention is required during exposure, this requirement may easily be met. The radium or radium emanation is usually transported in a small but heavily walled lead box and handled with long forceps. The authors have been assured by medical practitioners that there should be no objection to the use of gamma rays for the purpose discussed here because of possible harmful effects to the operator, if reasonable care is exercised in handling.

It is probable that in the future substantial amounts of radium will be imported for radiographic use and distributed throughout the country for rental, making it unnecessary for manufacturing plants to buy expensive X-ray equipment. All development along such lines would obviously increase the availability of radium for cancer treatment. It is also probable that some industrial concerns will have so much radiographic work to be done that they will want to install a supply of radium for their own use. For such purposes radium itself (rather than radium emanation) would be used, sealed in a small metal capsule.

The amount necessary depends on the speed desired in taking radiographs—the more the radium the less the necessary exposure time under a given set of conditions. The most economical use of the radium would involve planning exposures so that it would be in continuous use.

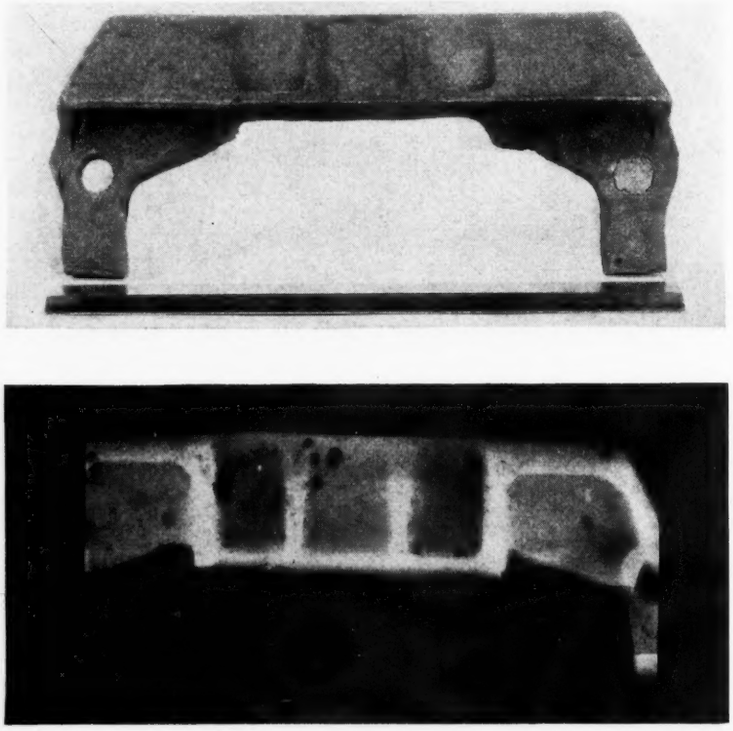
Suppose, then, we assume that a manufacturer wishes to have enough radium to inspect a group of steel castings 4 in. thick each 24 hr., the films being placed 18 in. from the radium. The radium requirements would be 0.1 gram. Similarly, with 5 in. thickness films 18 in. from the radium would require about 0.2 gram, and with 6 in. thickness about 0.4 gram.

The first two amounts mentioned would involve an initial cost about

the same as a complete X-ray installation capable of radiographing thickness up to 3½ in., but due to the long life of radium (it decays 50 per cent in 1,580 years) depreciation costs amount to almost nothing. The radium may be completely covered by insurance; the danger of loss is very slight, for radium may be detected at large distances by electrical methods.

A practical application that has been made of the method will be of interest. Last year a 10,000-ton cruiser was finished for the United States Navy. It had installed upon it a stern post casting weighing nine tons, designed to take the bending moment of the rudder. After the casting had been installed and ship trials made, cracks began to appear in this casting. They were promptly welded, and it was fervently hoped that they corrected the only defects present in the casting. Naturally, this could not be certain, and it was important to have some real assurance on the point.

Representatives of the Division of Metallurgy at the Naval Research Laboratory were requested to apply the gamma-ray inspection method, newly developed at the laboratory, to the casting. The use of X-rays was impossible in this case, because of the awkward position of the casting. With radium emanation equivalent to about ⅓ gram of radium, 24 areas measuring 10 in. x 12 in. were radiographed, the whole job requiring only about 24 hr. The casting was found to contain numerous internal cracks and voids; the result of the investigation was far from reassuring.



Figs. 4 and 5—Comparison of ordinary photograph of casting and radiograph (Fig. 5) showing blow holes as dark spots

In the final trials of the ship subsequent to this inspection the casting virtually split in two, with the direct result that the ship is now in dry dock for complete replacement of the casting, at a cost of about $200,000.

There was no radiographic inspection of this casting prior to installation; it is highly probable that this misfortune would have been avoided had there been one.

So much for the practical application of radium emanation in the examination of heavy metal objects for defects. Scientifically inclined readers may find additional points of interest in the following brief outline of the life history of this radium.

Radium is continuously breaking down and throwing off radiations in the process. The first product breaks down into a second and so on. At each stage radiations are given off. There is no way known to man whereby this process can be speeded up or slowed down in the slightest. It proceeds as inevitably as the movements of the earth, moon and planets in their orbits around the sun.

From radium and its products three types of radiation, known as alpha, beta and gamma rays, respectively, are given off. The alpha rays are known to be helium atoms with a double positive charge of electricity. Beta rays are simply electrons traveling at enormous velocities. Gamma rays are invisible light waves of very short wave length.

The first product of the decomposition of radium is radium emanation, or radon. This is a chemically inert gas more than one hundred times as heavy as hydrogen. In the process of transformation of radium into radon, alpha rays are given off.

This change of radium into radon is so slow that for all practical purposes the life of radium may be considered perpetual. Fixed charges are all interest; there is no appreciable depreciation. It takes 1,580 years for a given sample of radium to change 50 per cent to radon, another 1,580 years to change half what is left, and so on forever. In short, the change **from** radium to radon and every other change of one radium product to another follows what is known as the "logarithmic law of decay."

However, the succeeding transformations are increasingly rapid. Radon changes into radium A and decays 50 per cent in 3.85 days (that is, the "half life" is 3.85 days). Again alpha rays are given off in the process.

The half life of radium A is only 3.05 min. Its radiation is alpha rays and its product radium B. With a half life of 26.8 min., radium B decomposes into radium C, giving off beta rays and gamma rays.

Radium C decays 50 per cent in 19.5 minutes, again giving off beta rays and gamma rays. This decay yields two products, radium C′ and radium C″. The former has a half life of one millionth of a second, radiating alpha rays. The latter has a half life of 1.32 min. and gives off beta and gamma rays.

The series continues through the products radium D, E, F and G. Radium G, the final product, is simply lead, almost indistinguishable from ordinary lead.

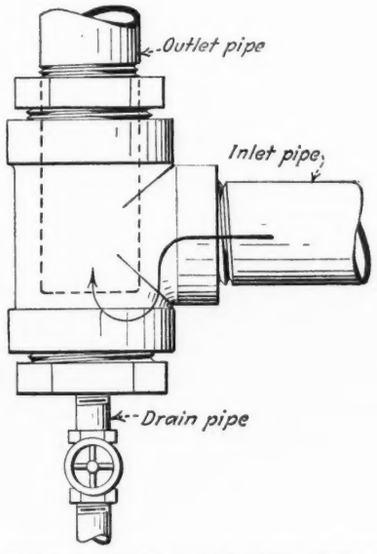
This long history is briefly summarized here not because it concerns the practical engineering applications of gamma rays, but as an extremely interesting bit of scientific information. The growing applications of radium are additional evidence, if any is needed, that research in pure science ultimately bears fruit of a highly practical nature.

...RIGHT OUT OF THE PLANT...

Home Made Apparatus Inefficient

TO GET dry steam for a manufacturing process, the operating engineer contrived a home-made separator the parts of which comprised a 3x2½-in. tee, a 3x2½-in. bushing and a 3x¾-in. bushing. These fittings were put together as shown in the sketch. The outlet pipe had a running thread, which permitted it to be run through the top bushing to a plane slightly below the side opening of the tee. It was expected that the current of steam entering through the horizontal pipe would whip out its moisture as it passed around the edge of the vertical outlet pipe, as indicated by the arrow. Then the accumulated water would pass out through the drain pipe to a steam trap.

Very often, a little checking up will show that the home-made device is far less adaptable and efficient than the regularly manufactured article would be. Steam



Steam separator formed of pipe fittings

separators of many different types are available, and it is easy to procure one that will meet the peculiar requirements of any situation. The various designs have been worked out by men who have given the problem of steam separation special study. As against the advantages which these devices secure, their cost is comparatively low. So it appears to be a waste of time and money for anyone to knock together a home-made contraption that does not embody even the fundamental principles upon which adequate steam separation is based.

To properly fulfill its purpose, a steam separator must have adequate volume. This is a prime requisite that cannot be secured by an arrangement of pipe fittings. To get the possible maximum of separation, provision must be made for momentarily reducing the velocity of the steam current, so that gravitation may have a chance to pull out most of the particles of water held in suspension, thus insuring that the steam shall pass on practically dry. Ample volume secures this lessening of the velocity. It also provides the storage capacity so necessary where unsteadiness in the demand for steam prevails, as where the steam is delivered to an engine carrying a variable load.

The working area inside a steam separator should be at least three times the area of the inlet and outlet ports, to avoid, so far as possible, the effect of friction, the diminution in the velocity of flow being due solely to the enlarged volume which the steam encounters.

St. Louis, Mo. A. J. DIXON.

When Should Outboard Bearings Be Used on Motors?

ON SEVERAL occasions I have had to instruct motor users on the recommended practice for using outboard bearings on electric motors. It is evident that the use of outboard bearings is not understood by many purchasers of motors for industrial drives. A table published by one of the leading motor manufacturers gives the limit of size of two-bearing motors as 40 hp. at 1,800 r.p.m., 75 hp. at 1,200 r.p.m., 125 hp. at 900 r.p.m. for belt drives. When chain drives are used the limits are given as 15 hp. at 1,800 r.p.m., 25 hp. at 1,200 r.p.m., and 50 hp. at 900 r.p.m.

In my work I frequently have to recommend a 75-hp., 900-r.p.m. motor for a certain drive. From the foregoing recommendations, a two-bearing motor of this size can be used with a belt drive, but an outboard bearing should be used with a chain drive. It is generally known that an outboard bearing is used to prevent shaft deflection and to prevent excessive bearing pressure on the drive end of the shaft. However, it is not so commonly appreciated why an outboard bearing may be required with a chain drive and not when a belt is used.

There are two reasons for using outboard bearings on motors of smaller ratings connected to their loads with chain drives. The standard sprocket diameter for a chain drive on a motor shaft is approximately one-third that of a standard pulley for a flat belt drive. As a result, the speed of a belt under average conditions is about three times the speed of a chain drive. This requires that the pull in the chain be approximately three times that in the belt for the same output. The greater

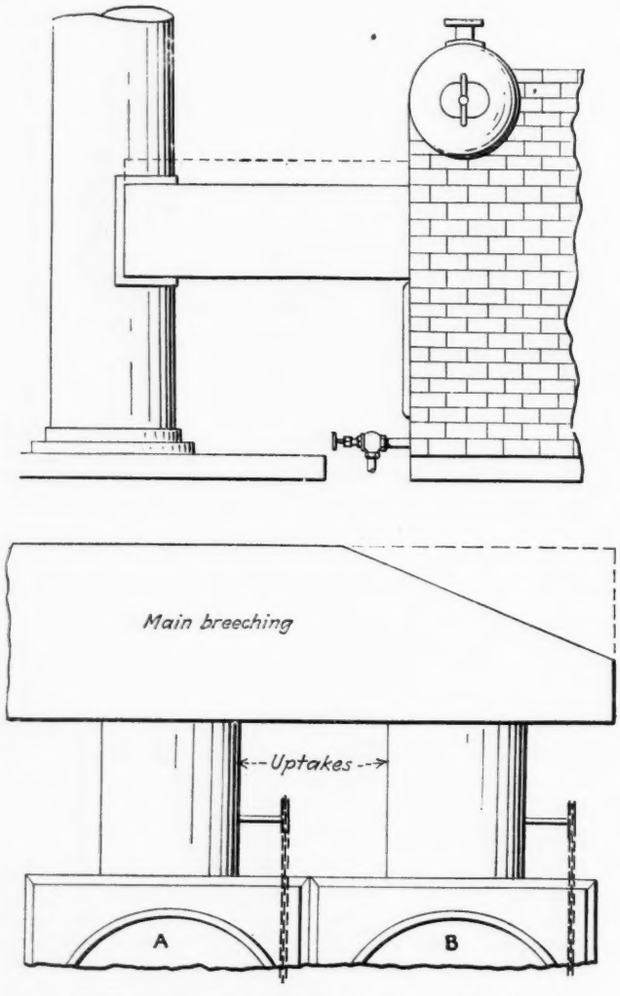
load in the chain tends to deflect the motor shaft and cause unnecessary wear of the sprocket and chain because of misalignment. With a flat belt a small amount of misalignment does not have as serious effect as with a chain or gear drive. Also a chain is a positive drive, consequently load shocks are transmitted to the motor bearings more readily than with a belt drive, which can stretch or slip to relieve the peaks of the shocks.

• San Antonio, Texas. R. H. PARRISH,
Alamo Iron Works.

Ample Breeching Areas Desirable

MANY boilers fail to perform according to expectations because their settings are poorly designed. The boiler may be set too close to the grate or there may be inadequate exposure of the water surfaces to the gases of combustion. Improperly designed breechings are to blame for poor economy, in many instances the breeching connection being too small to provide the necessary area for free escape of the burned gases from the boiler.

A case in point was that of a water-tube boiler of the cross-drum type. A test showed the boiler and furnace efficiency to be low. As an experiment, it was decided to enlarge the breeching between the setting and stack, as indicated by the dotted line in the upper view. And the experiment worked, as was evidenced by a greater output of steam with a considerably smaller consumption of fuel. The chimney draft had been fairly good, but the restricted breeching introduced too much resistance to the flow of the gases between the boiler and the stack. Discovery of such a condition is facilitated by having a double connection for the draft gage, one branch running to the furnace and the other to the base of the stack or chimney.



Changes made in breechings to give required area

Another instance in which remodeling of the breeching was necessary to cure defective boiler operation is shown in the lower view. Two return-tubular boilers were connected to the same horizontal breeching, but the space into which the chimney gases passed directly from the uptake of boiler *B* was contracted by the tapered end of the breeching. As a consequence, boiler *A* did most of the work when the dampers had equal opening. By careful adjustment of the damper above boiler *A* the two boilers could be made to work uniformly, but not without almost constant attention. Removing the tapered portion and carrying the breeching out full size, as indicated by the dotted lines, remedied the difficulty.

In computing the requisite size for a breeching, some engineers use the rule-of-thumb method of allowing 3.5 sq.ft. of cross-section per 1,000 sq.ft. of boiler heating surface. This is all right if the computation gives the net, or effective, area. If the breeching is round and straight and entirely unobstructed throughout its length, the gross area also will be the net area. But where short turns and angles are necessary in the breeching construction, allowance must be made in figuring the actual net area. It is quite probable that the cross-sections of many breeching connections in use would have to be expanded as much as 20 per cent to give the required net effective area. D. J. ALLISON.

St. Louis, Mo.

One Solution to the Power Plant Engineer's Problem

FREQUENT discussion of problems confronting the engineers and operators employed in industrial, manufacturing and fabricating plants reveals definitely the desire for a recognition of services performed in the form of more money and promotion. Assurance of permanent employment is often much desired. Men having all of these may simply feel the lack of sufficient recognition and proper appreciation. In short, they are confronted with a personal problem. How they solve it will determine whether the firm and they will profit by past investment in experience and training. Analysis shows that there are fundamentally two principal angles to such a problem. It may be that it is a problem of accomplishment and achievement. The engineer-operator must first demonstrate by actual performance his abilities and establish records in the form of an actual and essentially important improvement and contribution to the efficiency of the operation.

A power plant operator whose title was mechanical engineer, and whose duty, in addition to acting as chief engineer of the power plant, was to maintain and keep in proper repair and operating condition all the machines and units in a steel fabricating plant had come up from a watch engineer and oiler to this responsible position. Several hundred employees and the entire production of the plant depended upon his efficient discharge of his duties. Whatever the plant lacked in

equipment and organization this man made up in ability and experience in meeting and solving problems.

His record for achievement was good. He had designed production machines, made layouts and was able to produce practically perfect design drawings for any machine or structure. He did this in his spare time and became a capable engineer; so the production manager and the works managers depended upon him in many emergencies. He was the one man in the plant contacting and dealing with all departments.

Moreover, he had been able to develop a power plant second to none in efficiency, and kept his operators trained, organized and on the job. He produced power for a low cost and saved his company thousands of dollars a year. He was able to get up-to-date machinery and equipment with which to operate; but, on the other hand, if he could not get it he was able to design and build much of it in the machine shop.

Naturally he arrived at the point eventually reached by every man who makes achievement paramount to success. After fifteen years' experience, he felt he deserved more money, which he did, better recognition, which he should have had, and further assurance of permanent employment. He was face to face with the old problem of getting his idea before the executives of the organization. He had been able to sell them one progressive move after another, but in selling himself he was about to fail.

His problem was not then one of achievement and accomplishment, rather it was a problem of decision, involving his decision of how and where he wanted to fit in and how to secure a decision of the men higher up who could give him the recognition he desired and deserved. Finally he sought my advice, and I found that he, like so many engineers, did not know how to sell his achievements, and what step to take to get recognition.

The first effort had been a letter requesting a raise in salary, and after that, nothing, while waiting action. During the following weeks and months, he brooded over it, and his attitude and personality in dealing with the department executives seemed to change. He seemed to think that he should be recognized without any effort on his own part.

It required little time to rehabilitate him once he realized he was standing in his own light. Indirectly, it was brought about in this manner: I inquired about the man among the department heads, gained their point of view and reported back to him the exact feeling and opinion then existing and showed how he himself had brought about this feeling. It was also plain that the executives wanted to see him regain his former attitude.

Finally he made the decision to take his destiny in his own hands and accept his own responsibility, instead of depending upon others. After a few days of getting up courage, regaining his former energy, snap and enthusiasm, he walked up to his works manager, in all good faith and earnestness, and requested him to accompany him to a conference with the president of the company, in whose hands rested the authority for promotions and raises.

It turned out that this was just as simple a matter and as easy to do as a conference on the purchase of a new lathe or any other machine. It was all over in a few minutes. He got his raise and a new title of chief engineer in charge of plant and maintenance. Deserving men with records for accomplishment need only, in most cases, to come to the right decision and act upon it.

Dallas, Texas. ORVILLE ADAMS.

Wreck of Generating Unit Caused by Careless Setting of Circuit Breaker

THE POWER PLANT EQUIPMENT of a coal company in Wyoming with which I was connected included two 300-kw., 250-volt, 1,800-r.p.m. compound-wound turbine-driven generators, operated non-condensing. The generators furnished power for locomotives, hoists and other equipment in a mine not far from the plant. Owing to the unusual demand for coal at the time, there were several cases of oversight on the part of the man in charge of the plant.

Considerable trouble was experienced in keeping the circuit breaker closed on the main direct-current feeder because of the heavy overload being carried. The chief electrician was notified of the condition on numerous occasions, and remarked that he was tired of being troubled with what he termed "an insignificant item." And with the idea in mind of eliminating the inconvenience he reset the breaker to the maximum capacity.

One afternoon, while the operator was performing his duties outside the plant, he heard an unusual noise in the plant and upon entering found the machine running away.

When the machine was finally stopped it was found that the armature was stripped of the winding, the brush rigging was broken, the governor was out of commission, and several parts of the machine were broken and strewn about the plant. The trouble had started with a heavy short circuit caused by a bare feeder cable dropping on the track rail and water pipe in the mine. Owing to the drag on the generator, all steam inlet valves on the turbine had opened wide, causing the machine to overspeed when the short opened. RALPH E. MACKAY.

Butte, Mont.

Oil Grooves in Bearing Housings Stop Oil Leakage

A RECENT article entitled "Oil Grooves in Bearing Housings Stop Oil Leakage" was of considerable interest to me, and while, in my opinion, the method suggested is a good one, it will not cure the trouble in every case.

On several occasions conditions of this kind have come to my attention. In a 300-kw. generator the oil leakage was persistent and had been so for a considerable time, resulting in three repair jobs, "replacing carbonized mica" to remove grounds.

Every conceivable form of wipers, rings, etc., was employed to prevent the oil from working out on the shaft and into the commutator, but to no avail.

Upon examination it was found that the bearing was not in true alignment with the shaft, that is, the front cheek-block was slightly tangential and was set so close on the commutator end that the oil was wiped off and picked up by the ring and thrown out into the ring recess, causing it to splash on to the shaft outside the ring and travel along the shaft to the commutator.

My experience convinces me that there are four major causes for this annoyance: Bearing misalignment, too much oil, or oil of too high viscosity, and front cheek-block being improperly or insufficiently grooved.

New York City. L. K. ELLSWORTH.

From Among Readers' Problems

Conducted by
L. H. MORRISON

LOCATION OF STEAM OPENING IN STIRLING BOILER—*Why is the steam nozzle placed on the same drum of a Stirling boiler that carries the feed-water connection.* C.A.H.

In some three-drum boilers steam is taken from the middle, while in others the connection is on the rear drum, which receives the feed water.

When a boiler is steaming rapidly the front tubes are filled with a mixture of water and steam, of much lower density than the relatively cold water in the rear tubes: likewise the water in the middle row of tubes is a steam-water mixture. It follows, then, that the water level in the front drum is considerably above that in the middle drum, while the level in the rear tubes may be below the drum. There is, then, more or less danger of priming if the steam is taken from the center drum, especially if the water in the gage glass is carried relatively high.

Taking the steam from the rear drum, there is less danger of priming, since moisture carried over with steam from the middle drum will have an opportunity to drop out, and there is no ebullition of water in the rear drum, which may contain no water at all.

—❖—

EFFICIENCY OF A LOCOMOTIVE-TYPE BOILER—*We are thinking of installing a locomotive, or water-leg type of boiler for heating purposes. It has been claimed that the efficiency is much lower than that of a brick-set tubular boiler. Is this correct?* J.R.

The locomotive type boiler will not stand much forcing, but under normal rating it will show approximately as good an efficiency as the return tubular boiler. In a recent test with a stoker-fired boiler, an efficiency of 74 per cent was obtained.

—❖—

CURRENT TRANSFORMERS OPERATED WITHOUT LOAD—*Why must the secondary of a current transformer be short circuited when disconnected from its load?* F.E.B.

There are several reasons why the secondary of a current transformer should never be left open circuited. A current transformer is connected in series in the line, consequently its primary current is limited only by the load on the line. With the secondary open, the current transformer becomes a choke coil in the line, just the same as any coil on an iron core would be. With a heavy load on the line the choking effect may cause a considerable voltage drop that would interfere with the operation of other equipment on the system.

The core iron of a current transformer is normally operated at a low magnetic density. This is done to insure a practically constant ratio between the primary and secondary windings, and also to keep the ratio permanent. If the secondary is left open, and a heavy load is put on the primary, the core iron may become over saturated and change the magnetic characteristics of the iron, and consequently change the ratio of the transformer.

On account of the very large increase in the magnetic density of the core, there is a large increase in the secondary volts. This voltage is dangerous to anyone that might be working around the transformer, and it may break down the insulation. Also, the high magnetic losses in the core may cause the transformer to overheat and destroy the insulation.

PREVIOUS QUESTION
DISCUSSED BY READERS

THE QUESTION

WOULD you recommend electric welding of the seams of boiler drums where slight steam leaks occur, the boiler capacities and conditions being as follows: Steam pressure carried at 450 lb. gage; feed water temperature, 250 deg. F.; heating surface, 10,000 sq.ft.; average rating, 250 per cent? The longitudinal seams are double-strap butt joints and double-riveted drum; heads are attached to the shell with double-riveted lap joints. The boilers are built in accordance with A.S.M.E. Boiler Code. A.O.

LEAKY SEAMS indicate either a poor job of riveting or corrosion due to improper feed-water control. In either case the trouble can be overcome without welding.

The seams and rivets should be carefully examined. If any evidence of corrosion is found, immediate steps to remedy the condition of the feed water should be taken. In case corrosion is far advanced, the advisability of further service must be determined. Any loose rivets should be removed and replaced, and the rivets and seams should be carefully calked on the inside.

Although arc welding seems to be a quick and easy method of sealing these leaks, it should not be recommended without a great deal of thought and consideration of the specific conditions. The metal deposited in a weld is cast, and unless properly annealed it has a low tensile strength. A seam on a boiler drum already in service could hardly be annealed. The welder may penetrate too deeply into the drum metal and so impair the strength of the metal that the drum will fail when service is resumed.

In the present state of the art, all welding on pressure vessels should be done in shops where proper heat-treating equipment is available. One cannot afford to take any chance with a piece of equipment as important and costly as a boiler. A. W. THORSON.
Detroit, Mich.

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INSIDE calking should only be used for stopping the slight local leaks along the boiler seams. To weld them along the edges of the outside cover plates would create two potential sources of trouble.

An ideal condition for embrittlement would be set up in case there is any feed-water trouble due to a high carbonate-sulphate ratio, or if the feed-water is overtreated with soda ash or zeolite. Water will be drawn under the straps by capillary action at the points where the straps are not in close contact with the shell. At the temperature of 456.5 deg. F., corresponding to 450 lb. pressure, the sodium carbonate in the water will readily break down and react with the water, forming sodium hydroxide and carbon dioxide. Since there is no circulation of this water entrapped under the seam, the concen-

A Question for Our Readers

IN CONNECTION with a pump bid it was necessary to figure the over-all water-to-wire efficiency of a combined unit consisting of a motor-driven vertical turbine pump and a horizontal centrifugal motor-driven pump. The turbine pump lifted the water to the surface of the ground and the centrifugal pump then lifted the water from there to an elevated tank. What formula can be used to figure this over-all efficiency when the brake horsepower of each pump at its flexible coupling and efficiency of each pump and motor are known?

Suitable answers from readers will be paid for[1] and published in the March 31 number

tration of the solution of sodium hydroxide will increase and result in the grain-binding material of the metal being attacked along the general line of greatest mechanical stress, with possible eventual major failure. The welding of the seam will also effectually shut off the pin leaks whereby cases of embrittlement are sometimes detected.

It is quite possible that after the welding operation, when the shell is raised from room temperature to 456.5 deg. F., local stresses far beyond the safe point may be set up due to the constraint of uniform expansion. This could be likened, after a fashion, to the pinching of an inflated toy balloon.

HAROLD M. WRIGHT.

Troy, N. Y.

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THE FACT that the weld proposed is only a calking weld and as such is not supposed to carry much stress is somewhat misleading. A cross-section of the type of joint under discussion, with the outside strap calk-welded is shown in the figure. An elementary strip of the joint has two inside rivets in double shear and one outside rivet in single shear.

There is only one outside single-shear rivet between the weld and the solid plate, and before the two inside double-shear rivets can take a load that would produce the calculated deformation of the plate in length *A* the weld of length *B* must be stretched badly. If the weld holds, all well and good, it may perform its function of keeping the joint tight. Furthermore, the shrinkage of the weld on cooling is resisted by a compressive stress in the plate or a tensile stress in the strap. Welds of this type have opened because of the rigid construction preventing shrinkage. The shrinkage stress can be eliminated by heating the entire joint, but the weld must still function as a structural element when the shell is under pressure.

I would not hesitate to recommend welding of the seam to obtain tightness, but the weld must be of sufficient cross-section to serve as a structural element—which it is. It would then be a complete fillet, as shown by the dotted curve.

In view of what has been learned of plate embrittlement being caused by leakage of highly caustic water into riveted seams, it might be advantageous to weld the edges of the inside strap. Because of the reasons mentioned, however, this weld must be capable of large stress, which would add considerably to the cost of the drum.

Pending the general adoption of the all-welded boiler, delay of which is occasioned by factors largely psychological, boiler seams might be constructed as shown in Fig. 2. Here we have a single outside strap with the rivets that give comfort to some folks, and a weld that will prevent leakage and subsequent caustic embrittlement. The joint should be first welded and then riveted, in order to prevent the high shrinkage stress due to the rigidity of the strap. In either case the weld will carry a large part of the total load because of the inevitable slip of the riveted part of the joint.

C. O. SANDSTROM.

Los Angeles, Calif.

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FOR THREE YEARS I have been in charge of a three-furnace, 168-in. Scotch marine boiler. The diameters of the furnaces are 46 to 48 in. measured on corrugations, and the boiler has 334 3-in. tubes.

This type of boiler has a considerable unbalanced temperature difference, that is, the shell in contact with the water under the furnaces nearly always remains hand-bearable in temperature, while above the furnaces the shell temperature is that of the steam.

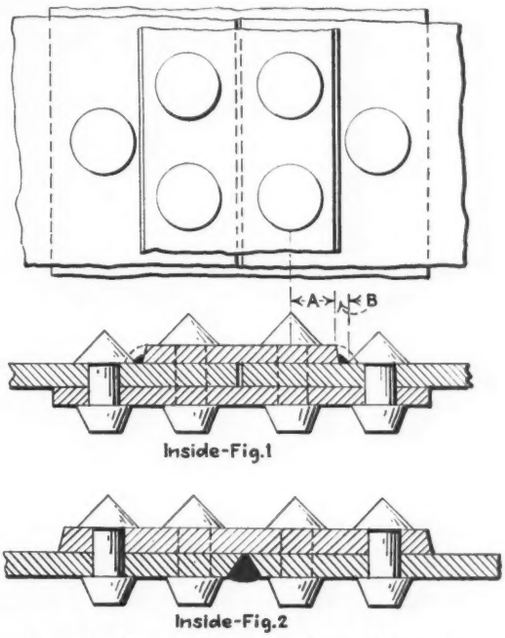
These temperatures set up stresses in the shell, and it seems that the horse collars, or back sheets, of this particular boiler suffer the worst.

The upper half of the horse collar is bathed in hot gases, but the lower half usually is buried in the accumulated ashes of the back connection, and it is here the leakage occurs.

These seams have been calked from time to time, until finally the calking edge was gone. Then the seams were welded, and since the welding was done I have noticed no leaking in the welded work, with the exception of a pin hole, which was closed with a tap or so from the peen of a hammer.

Because this is inside work, subject to the extremes of fire and water and undergoing much more severe working conditions than the outside shell, and has given me such good results, I heartily recommend that "A.O." weld his seams.

S. C. CARTY,
Chief Engineer.
U.S.S. Board "Tug Hawk"



Cross-section of joint with welded calking edge, and a better method of welding shown in Fig. 2

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THE ANSWER is "yes," if the engineer is in a great hurry and can obtain the boiler inspector's approval. But he should expect to have greater trouble in the future with the same seams owing to the breathing of the boiler producing crystallization at the weld.

My advice, based on experience with both fired and unfired pressure vessels, is to calk the seam inside the boiler.

A good way to locate the leak on the inside is one of old standing and known to many engineers. When the boiler is cold enough to be entered, take some soapsuds and smear the location of the leak, which can be found by tapping with a hammer on the outside. Then have an assistant play an air hose on the outside along the leaky section and the air will blow through and form bubbles along the inside, giving the desired location or spot.

Almost every mechanic or boiler maker can calk, but I would hesitate to say all can weld.

J. DRUMMOND.

Long Beach, Calif.

[1]Instead of cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired.)

Morrison's *American Diesel Engines*; Walker and Crocker's *Piping Handbook*; Norris and Therkeisen's *Heat Power*; Emswiler's *Thermodynamics*; Church's *Steam Turbines*; Uehling's *Heat Loss Analysis*; Croft's *Steam Power Plant Auxiliaries and Accessories*; Powell's *Boiler Feed Water Purification*; Osborne's *Power Plant Lubrication*; Moyer and Fitz, *Refrigeration*; Rietschel-Brabbee's *Heating and Ventilation*; Annett's *Electric Elevators*.

NEWS of the FIELD

Five States Attack Federal Water Power Act at Hearing on New River License

ATTACKING the key provision of the federal water power act, as encroaching on state rights, representatives of five states and counsel for the Appalachian Electric Power Company declared at a public hearing before the Federal Power Commission on Feb. 16 that the commission lacks jurisdiction to issue a license to the Appalachian company to construct an $11,000,000 power plant on the New River, near Radford, Va., because the stream is non-navigable. The states and the company's counsel asserted that if the government decided it had authority, then its powers extended only to issuing a license that would protect navigation on the Kanawha River, into which the New River empties.

The conflict between the states and the government centered on the type of license sought by the company, which has asked for a modified or "minor part" license, not requiring the strict accounting of the major license. Virginia, West Virginia, Tennessee, Kentucky and Arkansas joined in backing the Appalachian company's claim. They pictured the case as establishing an important precedent.

The states brought out in their pleas that water-power development within their borders was being impeded by the pending application and urged that the license be granted as sought by the company. In addition the states challenged the commission's right to issue a license on a non-navigable stream that would provide for recapture by the government of the property at the expiration of the license in 50 years on payment of a fair value; expropriation by the government of excess profits, and regulation of any other parts of the project except those dealing with navigation or interstate commerce in power.

A possibility the present commission may refuse to accept the findings of the former commission of cabinet members, before whom the application was pending since 1925, was indicated by Commissioners Williamson and McNinch. The former commission declined to act on the application, holding the question of state or federal jurisdiction too important to be determined without a court ruling.

Commissioner McNinch declared that "the duty of this commission might be to reconsider the evidence as to the navigability of the river and other data and call for a full and fair rehearing." The company once was granted a major license but rejected it.

On the request of attorneys for the power company the commission allowed until Feb. 28 for the filing of an additional brief. A telegraphic request from Governor Pinchot of Pennsylvania, asking permission to file a brief also was granted. In his telegram Governor Pinchot protested against the issuance of minor license for the project.

North Tonawanda to Have New Central Steam Plant

PERMISSION to construct a central steam station in North Tonawanda, N. Y., was granted Feb. 16 to Arthur J. Slade by the New York Public Service Commission. Mr. Slade proposes to organize a steam corporation and undertake the construction and operation of a steam plant and distribution system to furnish steam for heating and power. This permission is contained in a 25-year franchise granted by the city which is to have first choice for the use of the steam in schools and other public buildings. Mr. Slade is to pay the city 2½ per cent of the gross receipts from the sale of steam and the city reserves the right to purchase the plant under certain conditions.

No steam is now furnished to the public in North Tonawanda. The franchise covers the entire city but construction is to be begun in a limited district surrounding the city hall, which is a well populated residential area. It is proposed to charge about 50c. per thousand pounds for the steam.

318,000-Kw. Extension to London Plant Approved

PERMISSION has just been granted by the British Electricity Commissioners to extend the generating station of the Fulham Borough Council, London, England, in stages to an ultimate capacity of 318,000 kw. at an estimated cost of $26,250,000. The first section, which the council has been authorized to carry out immediately, will have an installed capacity of 132,000 kw., and it is expected to be in operation within three years.

The commissioners' statement follows a public inquiry held in December, when various objections to the erection of the station at Fulham were considered. The commissioners attach to their consent certain conditions which were settled in consultation with the health ministry and the office of works. The consent places the council under statutory obligation not to operate the generating station when enlarged so as to occasion a nuisance, and to that end requires the council to use continuously the most efficient methods that may be reasonably practicable to eliminate smoke and grit, to prevent the discharge of sulphur and its compounds into the atmosphere and to avoid noise or vibration arising from the operation of the power house.

A. I. E. E. District Meeting In Pittsburgh, March 11-13

PROGRAM has recently been announced for the Middle Eastern District meeting of the American Institute of Electrical Engineers, which will be held at the William Penn Hotel in Pittsburgh, Pa., from March 11 to 13.

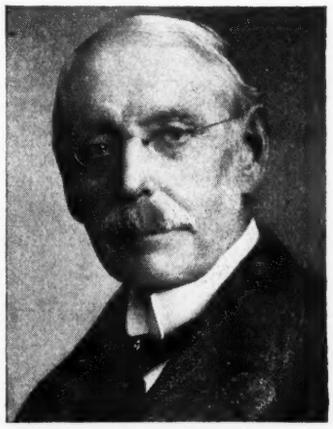
Among the technical papers scheduled for presentation at the meeting, the following are of interest to power engineers: "Conversion and Distribution of General Purpose D-C. Power in Large Industrial Plants," by R. D. Abbiss and D. C. West; "Interconnection Between the Duquesne Light Company and the Davison Coke & Iron Company," by G. E. Dignan and R. L. Kirk; "Interconnection for Power Between Public Utilities and Large Industrial Users," by F. O. Schnure; "Absorption of By-Product Power," by A. Hoefle and W. T. Woodmancy; "The Use of Electricity in Large Annealing Furnaces," by J. C. Woodson; and "The Use of Electricity in a Modern Dairy Plant," by H. C. Brunner and A. G. Droux.

Inspection trips listed on the program include visits to the East Pittsburgh works of the Westinghouse Electric & Manufacturing Company, the Springdale power station and coal mine of the West Penn Power Company, and the James H. Reed power station of the Duquesne Light Company.

Charles Parsons, Turbine Inventor, Dies on Cruise

SIR CHARLES PARSONS, K.C.B., inventor of the reaction steam turbine and one of the world's foremost engineers, died suddenly on Feb. 11 aboard the liner Duchess of Richmond, while on a pleasure cruise to the West Indies. He was born in London, England, on June 13, 1854.

Unlike the majority of great inventors, Sir Charles began his career with many advantages. His father, the Earl of Rosse, was at one time president of the Royal Society and a scientist of distinction. He supervised the early education of Sir Charles and encouraged him in the study of science. Later he attended St. John's College at Cambridge, where he studied the earliest forms of rotary engines and turned his attention to the possibility of designing a steam turbine.



Sir Charles A. Parsons

In 1883 he became a junior partner in the engineering firm of Clarke, Chapman, Parsons & Company, at Gateshead, and proceeded at once to put his ideas into practical form. The following year he built his first steam turbine—a small double-ended, parallel-flow machine which, running at the great speed of 18,000 r.p.m., drove a dynamo rated at 6 hp. Not satisfied with this, he proceeded to construct larger units, and by 1889 some 300 machines up to 75 kw. capacity had been built.

The partnership of Sir Charles with Clark, Chapman, Parsons & Company ended in 1889, and for the next five years he found himself cut off from the original patents, which remained with the firm. Unable, therefore, to work further on any form of parallel-flow machine, he and his colleagues turned their attention to the construction of radial-flow turbines, establishing a new firm at Newcastle, known as C. A. Parsons & Company, of which Sir Charles was the head at the time of his death.

He recovered his patents in 1894, and in that year built the first ship to be propelled by a steam turbine—the Turbinia, a 100-ft. vessel of 44 tons displacement, powered by a single radial-flow machine operating at 200 lb. steam pressure. In 1895 this turbine was replaced by three turbines in series, giving about 2,000 hp. and driving three shafts at 2,000 r.p.m. Attaining the phenomenal speed for that time of 31 knots, this installation demonstrated to the world the feasibility of propelling ships by turbines.

The number and variety of Sir Charles's inventions and engineering interests led to his acquiring or founding several other important companies. Besides being chairman of the Newcastle firm, he was also chairman of the Parsons Marine Steam Turbine Company, the Ross & Company optical works and the Parsons Optical Glass Company. He was made a Fellow of the Royal Society in 1898, and four years later received the society's medal. He was president of the Institute of Marine Engineers in 1905-06 and of the British Association in 1919-20. The Franklin Medal was awarded to him in 1920 and the Copley Medal in 1928.

A.S.A. Inaugurates Work On Belting Standards

INAUGURATION OF WORK on the development of national standard specifications for leather belting to permit the purchase on a scientific basis of the $30,000,000 worth of leather belting for driving machinery required annually by American industry has been approved by the American Standards Association. The general adoption of national standards for belting would result in savings of several million dollars annually, according to estimates based on the experience of industries in which belting specifications are used. Work on the project will be undertaken immediately by a technical committee made up of representatives of manufacturers, distributors, large industrial users of leather belting, and government departments. The American Society of Mechanical Engineers will direct the technical work of the committee under A.S.A. procedure.

Discuss Simplification Of Heating Boilers

A PRELIMINARY report of a survey, recently conducted by the division of simplified practice of the Bureau of Standards, on capacity ratings for low-pressure steel heating boilers, was reviewed at a meeting of the simplification committee of the Steel Heating Boiler Institute, held in Pittsburgh, Pa., recently. Following that the report was read before the annual meeting of the institute, where it was decided that a proposed simplified schedule of ratings should be drafted by the simplification committee as a basis for a simplified practice recommendation in this field. A complete summary of the results of this survey will be published as soon as all manufacturers have reported.

News of Canada

First unit completed at Falls River plant — Henderson and Morrisey made executives of United Engineers

NORTHERN BRITISH COLUMBIA POWER CORPORATION recently completed and brought into operation, the initial installation of one 6,000-hp. unit in its development on Falls River. This development supplements a small hydro-electric plant, heretofore in use, which was purchased by the corporation in 1929, from the municipality of Prince Rupert.

Falls River Power House

It is the first important step in the development of a number of power sites, which will form a network of plants to serve the northern part of British Columbia with the power necessary for the exploitation of the natural resources with which this territory is richly endowed. The new plant is situated about 35 miles southeast of Prince Rupert at the confluence of Falls and the Ecstall rivers, the latter being a tributary of the Skeena River. Power is carried from the development to Prince Rupert over a 66,000-volt transmission line. An interesting feature in this transmission line is the Skeena River crossing of 8,000 ft. with four spans, the longest of which is 2,100 feet.

Plans for future development of the plant provide for the installation of another 6,000-hp. unit, as the second stage and two units of 10,000 hp. each as the final stage, bringing the total installed capacity of the plant to 32,000 hp.

ANNOUNCEMENT has just been made by United Engineers & Constructors (Canada), Limited, of the election as president of Roy M. Henderson, formerly managing director, and the appointment of Lt.-Col. T. Sydney Morrisey as vice-president in charge of a new branch office in Toronto, Ontario.

Colonel Morrisey has been particu-

larly identified with steam-power development in Canada, having been the senior executive of Combustion Engineering Corporation for the past six years. He was responsible to a large extent for the first pulverized-fuel installation in Canada using Canadian coal at the St. Lawrence Paper Company mills, and is well known for his work in the study and development of Canadian coal for economical industrial application in the highly specialized and rapidly expanding steam-generation field.

Mr. Henderson is an executive of broad experience spread over a span of

Rice Montreal

T. Sidney Morrisey

more than 25 years during which time he has been in responsible charge of heavy engineering and construction projects in Canada, the United States and foreign countries, in the organizations of the present firm, its predecessor, Dwight P. Robinson & Company, Stone & Webster Engineering Corporation, and the Arnold Company.

Revised Lighting Course Announced by Westinghouse

To SATISFY the continuing demand created by the correspondence course in general illumination, in which more than 6,000 students were registered in 1930, a revised edition of the course will be made available this month for which registrations may now be made with the Westinghouse Lighting Institute, Grand Central Palace, New York City.

The technical data covered in the course was given in nine different lessons: light sources, units of light measurement and photometry, principles of light control and equipment, interior lighting calculations, commercial lighting, display lighting, industrial lighting, floodlighting and street lighting. The revised course will contain additional assignments on light sources, electrical advertising and conventional home lighting, but each question and problem in the assignments, which students are required to answer, will be changed completely.

This new course will be available throughout all of 1931 and is intended primarily for central station personnel that may be assigned to lighting work. No time limit for completion has been set, or period specified when registrations should be made.

COMING CONVENTIONS

American Society of Mechanical Engineers. Semi-annual meeting in Birmingham, Ala., Apr. 20-23. Meeting at Hartford, Conn., June 1-3. National Oil and Gas Power Meeting at the University of Wisconsin, Madison, Wis., June 15-16. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting in Pittsburgh, Pa., March 11-13. District meeting in Rochester, N. Y., Apr. 29-May 2. Annual summer convention in Asheville, N. C., June 22-26. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Spring meeting at the Hotel President, Kansas City, Mo., May 6-8. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at the Stevens Hotel, Chicago, Ill., June 22-26. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Annual meeting in New York City, Apr. 22-24. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual meeting and exposition at the Cleveland Public Auditorium, Cleveland, Ohio, June 15-19. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

1931 Midwest Bituminous Coal Conference. To be held at the University of Illinois, Urbana, Ill., May 21-22. Chairman of Program Committee, B. R Gebhart, Illinois Coal Bureau, 307 North Michigan Ave., Chicago, Ill.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago, Ill.

National District Heating Association. Annual convention at the Hotel Statler, Boston, Mass., June 2-5. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 8-12. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Universal Craftsmen Council of Engineers. Annual convention at the Sherman Hotel, Chicago, Ill., Aug. 4-8. Secretary of Convention Committee, James J. Blaine, 7342 Harvard Ave., Chicago, Ill.

Personal

DR. RALPH B. KENNARD, formerly head of the physics department of Robert College, Istambul, has been appointed a research associate of the United States Bureau of Standards, for research work covering the fundamental problems of heat transfer between solids and liquids, in accordance with the provisions of the Luther B. McMillan fellowship. This fellowship has been established by the Johns-Manville Corporation as a memorial to Mr. McMillan, who before his untimely death in August, 1929, was consulting engineer for the company and a pioneer in heat-transfer research. Dr. Kennard has specialized for some time in the field of thermodynamics, kinetic theory, electricity and magnetism. His publications have dealt with kinetic theory phenomena in high vacua.

OSCAR JUNGGREN, engineer at the Schenectady works of the General Electric Company who has designed steam turbines of the largest capacities—those in excess of 100,000 kw. of his design aggregating a total of 1,323,000 kw.—and the man who created the vertical-compound turbine, was one of the notable recipients of awards made by the Charles A. Coffin Foundation on Feb. 20. Thirty-seven other General Electric men, representing many classes of workers scattered among the company's various factories and commercial offices, also received awards, which consisted of certificates of merit and sums of money.

FLOYD L. CARLISLE, chairman of the board of the Niagara Hudson Power Corporation, was elected chairman of the board of the New York Edison Company at a meeting of directors on Feb. 17. At the same time Frank W. Smith, vice-president and general manager of the United Electric Light & Power Company, was elected vice-president of the Edison Company.

NORMAN R. GIBSON, vice-president and chief engineer of the Buffalo, Niagara & Eastern Power Corporation, was recently elected a vice-president of Niagara Hudson Power Corporation.

T. A. BURDICK, engineer of New York City, has been appointed manager of the power division of Alco Products, Inc., subsidiary of the American Locomotive Company. Mr. Burdick was formerly chief engineer of the General Water Works & Electric Corporation at Fort Worth, Texas.

J. W. JANTZEN, since Dec. 1, 1925, a member of the engineering staff of the Central Arizona Light & Power Company, Phoenix, has been appointed district manager of that company's Glendale office. He will be in complete charge of the company's operations in the Glendale-Peoria district, for which the office will be the Northern headquarters.

Business Notes

WORTHINGTON PUMP & MACHINERY CORPORATION, New York City, announces that at the recent annual meeting of its sales executives, H. C. Beaver, formerly executive vice-president of Rolls-Royce of America, was introduced as a new vice-president, who will be engaged mainly in the administration of the sales department. At the same time E. E. Yake was advanced to the office of vice-president to direct manufacturing and engineering. The corporation reports a most successful year in spite of economic conditions; it made 97 per cent of its sales quota, which was the same as that set for 1929.

FORD, BACON & DAVIS, INC., New York City, announces the opening of a new branch in the Union Trust Building, Cleveland, Ohio. It will be in charge of Edgar A. Rogers, former manager of the Philadelphia office. Major Shipley Thomas, formerly vice-president of the Benedict Stone Company, will succeed Mr. Rogers in Philadelphia.

AMERICAN HOIST & DERRICK COMPANY, St. Paul, Minn., and DOMINION BRIDGE COMPANY, LTD., and DOMINION ENGINEERING WORKS, LTD., both of Montreal, Canada, announce the formation of a subsidiary company, known as the DOMINION HOIST & SHOVEL COMPANY, LTD., to manufacture and sell in Canada and the British Empire the American Hoist & Derrick Company's line of hoisting and material-handling machinery. To be known as the "Dominion" line, products of the new subsidiary will be made and serviced at the Lachine, P. Q., works, near Montreal.

BYRON JACKSON COMPANY, Berkeley, Calif., announces that its Eastern office has been transferred from 1245 Graybar Building, New York City, to Bethlehem, Pa. While a sales office will be maintained in New York, the company states, all correspondence for the Eastern division should be addressed to P. O. Box 409, Bethlehem, Pa.

DIAMOND POWER SPECIALTY CORPORATION, Detroit, Mich., announces the appointment of the Arthur K. Jones Company, 417 S. A. & K. Building, Syracuse, N. Y., as sales representative in the Syracuse territory.

THE MERIAM COMPANY, Cleveland, Ohio, announces that notwithstanding the unfavorable general business conditions of the past year, it was able to declare a stock dividend of 100 per cent at the recent annual meeting of its directors. J. B. Meriam, president of the company, attributed this remarkable showing to the greatly increased interest throughout industry in cutting of operating costs through the more accurate measurement of liquid and gas flows and pressures.

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WITH THE SOCIETY SECTIONS

A.S.M.E., Metropolitan Section. Power Division meeting in Room 501, Engineering Societies Building, on Feb. 24 at 8 p.m. Subject: "Some Suggestions Regarding Harmonious Relationships Between Boiler Water and Metal," by R. E. Hall, Hall Laboratories, Inc.

A.S.M.E., Philadelphia Section. Meeting at the Engineers' Club on Feb. 24 at 8 p.m. Subject "Research in Industry," by C. F. Hirshfeld, Detroit Edison Company. The meeting will be preceded by dinner at 6 p.m.

A.S.H.V.E. and A.S.R.E., Boston Sections. Joint meeting at the Boston Chamber of Commerce on Feb. 26 at 6:15 p.m. Subject: "Air Conditioning," by D. C. Lindsley, Carrier Corporation.

Board of Examiners, Steam Boiler Branch, Montreal. Public meeting at the Engineering Institute of Canada on Feb. 27 at 8 p.m. Subject: "Welding of High-Pressure Boilers and Pressure Vessels," by J. E. Trainer, Babcock-Wilcox & Goldie-McCullough Company; also, discussion of the Canadian Interprovincial Code for the Construction and Installation of Boilers and Pressure Vessels.

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Trade Catalogs

LUBRICATION—A new 24-page bulletin covering the properties, uses and advantages as a lubricant of collodial graphite has just been issued by the Acheson Oildag Company, Port Huron, Mich.

VALVES—The Schutte & Koerting Company, 12th and Thompson Sts., Philadelphia, Pa., has just issued a new bulletin, No. 8-K, which describes and illustrates its line of bleeder-turbine protecting valves. Considerable data regarding construction features, sizes, prices and typical installations is included in the publication.

SWITCHBOARD—A new type of lighting panelboard is described and illustrated in a recent booklet of the Bull Dog Electric Products Company, 7610 Jos. Campau Ave., Detroit, Mich.

FURNACES—A new 80-page catalog and data book for refractory furnace engineers has just been issued by the M. H. Detrick Company, 140 South Dearborn St., Chicago, Ill. This publication contains an illustrated explanation of the underlying principles of Detrick air-cooled walls and arches, descriptions of representative installations and many useful charts and tables for calculating heat transfer through refractories, air required for cooling and other design factors.

GAS ENGINES AND PUMPS—Worthington Pump & Machinery Corporation, Harrison, N. J., has recently issued the following new catalogs: S-550-B2, covering horizontal four-cycle double-acting gas engines of 36-in. stroke and over; D-711-S5, covering horizontal double-acting power vacuum pumps; W-318-S2, covering Type UA two-stage volute centrifugal pumps; W-318-S7, covering Type UL two-stage volute centrifugal pumps; and W-320-S1, covering underwriter centrifugal fire pumps.

VALVES—Seven different types of relief valves are described and illustrated in a new 8-page folder recently issued by the Watts Regulator Company, Lawrence, Mass.

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Fuel Prices

FUEL OIL

New York—Feb. 19, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, contract, 6c. per gal.

St. Louis—Feb. 11, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.339 per bbl., or 42 gal.; 26@28 deg., $1.464 per bbl.; 28@30 deg., $1.589 per bbl.; 30@32 deg., $1.689 per bbl.; 32@36 deg., gas oil, 3.776c. per gal.; 38@40 deg., distillate, 4.526c. per gal.

Pittsburgh—Feb. 11, f.o.b. local refinery, 34@36 deg., fuel oil, 3.125c@3.5c. per gal.; 36@40 deg., 3.125c.@3.5c.

Philadelphia — Feb. 2, No. 4, light, $1.31 per bbl.; No. 5, medium, $1.22; No. 6, heavy (Bunker C) $1.10.

Cincinnati—Feb. 17, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—Jan. 16, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 60c. per bbl.; 22@26 deg., 67.5c. per bbl.; 26@30 deg., 80c. per bbl.; 30@32 deg., 95c. per bbl.; 32@36 deg., gas oil, 2.25c. per gal.

Boston—Feb. 16, tank-car lots, f.o.b. 12@14 deg., Baumé, 3c. per gal.; 28@32 deg., 5c. per gal.

Dallas—Feb. 14, f.o.b. local refinery 24@26 deg., $1.10 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.90 @ $2.25
Pool 10, h. gr. low-vol.	New York	1.75 @ 1.85
Pool 11, low-vol.	New York	1.60 @ 1.75
Smokeless, mine-run	Chicago	1.75 @ 2.25
Smokeless, slack	Chicago	.75 @ 1.35
Harlan, Ky., slack	Chicago	.70 @ 1.00
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.50 @ 1.60
Ind. 5th Vein, m.-r.	Chicago	1.20 @ 1.75
Standard Ill., mine-run	St. Louis	1.50
W. Ky., mine-run	Louisville	1.00 @ 1.25
W. Ky., slack	Louisville	.35 @ .40
Pittsburgh, mine-run	Pittsburgh	1.35 @ 1.45
Smokeless, mine-run	Cincinnati	1.75 @ 2.50
Smokeless, slack	Cincinnati	.75 @ 1.35
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, nut-slack	Cincinnati	.50 @ .75

Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.50
Barley	New York	1.50

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Upland—Water District 9, is having plans prepared for water supply system including deep well, booster pumping plant, etc. Estimated cost $45,000.

Colo., Grand Junction—Redlands Co., R. B. Dessert, Pres., Grand Junction, subsidiary of Cities Service Co., 60 Wall St., New York, N. Y., plans the construction of a new hydroelectric plant which will replace with a single unit, 1,500 kw. turbine, $100,000; plans also are under way for enlargement of distribution canal and improvements to Gunnison River dam, $150,000.

Conn., Bristol—Connecticut Light & Power Co., Riverside Ave., had plans prepared for the construction of a central steam heating plant on Riverside Ave. Estimated cost to exceed $40,000. H. A. Hayden, 175 Main St., is architect.

Conn., Hartford—Engineers Dept., City Hall, will receive bids about Mar. 10 for the construction of pumping station at South Meadows, also conduit through dike for sewerage and construction of pressure relief wells at ft. of Warwarme Ave. Estimated cost exceed $25,000. R. N. Clark, City Hall, is engineer.

Ill., Chicago—Commonwealth Edison Co., 72 West Adams St., awarded masonry contract for a 92 x 74 ft. sub-station at 252-60 Wendell St. Estimated cost $75,000.

Ind., Bloomington—County Commissioners, A. Eller, Auditor, plans the construction of a power house including brick stack, equipment, etc. Estimated cost $75,000. A. Grindle is engineer.

Ind., Noblesville — Indiana Electric Corp., plans improvements and additions to plant. Estimated cost $75,000. J. T. Kester, Noblesville, is engineer. Work will be done by owner's forces.

Ia., Cedar Falls—Iowa State Teachers College, c/o State Bd. of Education, W. H. Gemmill, Secy., State House, Des Moines, will receive bids in spring for the construction of a 54 x 135 ft. heating plant here. Estimated cost $385,000. E. E. Cole, Cedar Falls, is engineer.

Ia., Grundy Center—Northwestern Light & Power Co., Cedar Rapids, awarded contract for a 40 x 80 ft. addition to power plant to Zittrel & Mills, Webster City.

Kan., Goodland—Public Utilities Consolidated Corp., L. E. Lynch, Mgr., awarded contract for a 27 x 40 ft. addition to power plant to G. P. Reintjes, 2517 Jefferson St., Kansas City, Mo. Estimated cost $70,000.

Md., Baltimore—Biltmore Holding Co., C. E. Bentley, Pres., Emerson Hotel, had plans prepared for a 12 story club building including steam heating system, swimming pool, etc., at 219-25 North Calvert St. Estimated cost $800,000. F. A. Fletcher, 517 North Charles St., is architect.

Mass., Barnstable—Cape Cod Gas Co., P. P. Crafts, 1 State St., Boston, plans the construction of an illuminating gas plant here. Estimated cost to exceed $40,000. Engineer not selected.

Mass., Boston—Edison Electric Illuminating Co., 39 Boylston St., had plans prepared and will soon receive bids for the construction of a steam heating plant at Kneeland and Utica Sts. Estimated cost $750,000. Bigelow, Wadsworth, Hubbard & Smith, 11 Beacon St., are architects. Whitney Engineering Co., 250 Stuart St., is engineer.

Mass., Holyoke—Holyoke Water Power Co., 1 Canal St., plans extension to power station on Connecticut River. Estimated cost $40,000. Private plans.

N. H., Littleton—Littleton Hospital, H. M. Eaton, Pres., Bd. of Trustees, will receive bids about Mar. 1 for addition to hospital and power house. Estimated cost $150,000. Rich, Mathesius & Koyl, 320 5th Ave., New York, N. Y., are architects.

N. J., Jersey City—Bd. of Chosen Freeholders, Court House, is having plans prepared for a 16 story hall of records building, including steam heating and ventilation systems, boilers, elevators, etc., on Newark Ave. J. T. Rowland, 26 Journal Sq., is architect.

N. J., Jersey City—Jewish Hospital Association, B. S. Pollick, Chn., Laurel Hill, Secaucus, plans the construction of a 4 story hospital at Fowler and Van Nostrand Aves. Estimated cost $1,000,000. Architect not selected.

N. J., Jersey City—Mongiello Bros., 625 Communipaw Ave., postponed construction of a 100 x 100 ft. ice plant. $50,000. C. H. Ziegler, 26 Journal Sq., Archt. Indefinite when project will mature.

N. Y., Brooklyn—Supreme Coal & Ice Co., 551 Nostrand Ave., awarded contract for the construction of an ice plant at Lexington Ave. and Marcy Pl. to Oforu Inc., St. Marks Ave.

N. Y., Brooklyn—U. S. Navy, Public Works Dept., Brooklyn Navy Yard, will receive bids until Feb. 25, for addition to power plant including turbo-alternator. Estimated cost $80,000.

N. Y., New York—A. R. Manowaski, c/o Hotel Roosevelt, 45th St. and Madison Ave., will build a 47 story office and stores building at 441 5th Ave. Estimated cost to exceed $1,500,000. Jardine Murdock & Wright, 347 Madison Ave., are architects. Work will be done by separate contracts. Maturity April 15.

N. Y., New York—Two Beekman Place Corp., 5 Skillman Pl., Bridge Plaza, Long Island City, awarded contract for a 17 story apartment building at 15 Mitchell Pl. to Lane Ogle Inc., Pier 3 North River. Estimated cost $1,250,000.

N. Y., Watertown—Beebe Island Corp., Phelps and Hudson Sts., plans a water power development, 10,000 hp. capacity. Estimated cost $800,000. J. G. White Engineering Corp., 43 Exchange Pl., New York, N. Y., are engineers.

N. C., Winston-Salem—City plans the construction of a sewage system including pumping stations, mains, etc., at Waughton suburb. $116,000.

O., Cleveland—John Carroll University, M. J. Bervet, Chn., is receiving bids for the construction of a group of buildings including administration, service building, etc., at Warrensville Center Rd. Estimated cost $2,500,000. P. Lindsley Small, 1508 Terminal Tower, is architect.

O., Cleveland—May Co., S. L. Gross, Treas., awarded contract for addition to department on Euclid Ave. to Aronberg-Fried Co., Terminal Tower. Estimated cost $1,000,000.

Okla., Oklahoma City — Oklahoma City National Bank, awarded contract for the construction of a 32 story bank and office building, including heating system, etc., to Mahattan Construction Co., Tulsa. Estimated cost $3,000,000.

O., Lima—City plans the construction of a municipal power plant to serve all controlled institutions and all street lighting.

Okla., Ryan—City is having preliminary plans prepared for the construction of a 15 ton raw water ice plant. Estimated cost $30,000. Engineer not announced.

Texas—Central Power & Light Co., National Bank of Commerce Bldg., plans waterworks improvements at Edinburg, McAllen and San Benito to include new pumping equipment, etc. Private plans.

Tex., El Paso—Western Gas Co. (subsidiary of El Paso Natural Gas Co.) will soon award contract for constructing and equipping four complete booster stations for 12 in. gas pipe line between El Paso, Tex. and Douglas and Bisbee, Ariz. Estimated cost $1,000,000. Ford, Bacon & Davis Inc., 39 Broadway, New York, N. Y., are engineers. Work will be done under the supervision of Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass.

Tex., Rio Grande—Central Power & Light Co., National Bank of Commerce Bldg., San Antonio, is having plans prepared for the construction of a 45 ton ice plant. Estimated cost $40,000. Also plans improvements to ice and cold storage plant at Eagle Lake.

Tex., Yoakum — City, c/o E. S. Winfree, Mayor, awarded contract for the construction of a complete water system to include reservoir, two deep well pumps and two booster pumps to Kirkwood, Wharton & Lee, 518 North Flores St., San Antonio; also power and lighting system including complete distribution system, power plant building, cooling tower, fuel oil tanks, power and auxiliary equipment to Fairbanks-Morse Co., 1713 North Market St., Dallas.

Va., Quantico—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Mar. 18, for the construction of a boiler plant here.

Wis., Arcadia — City, R. N. Hohman, Clk., will receive bids until Mar. 17, for sewage treatment plant including pumping stations, etc.

Wis., Racine—City is having plans prepared for the construction of a new water pumping station. Estimated cost $500,000. Alvord, Burdick & Howson, 20 North Wacker Dr., are engineers.

B. C., Kaslo—City awarded contract for the construction of an electric light and power plant including dam, new 300 hp. automatic control turbine, direct connected to generator, switchboard and instruments to Electric Power Equipment Ltd., 1285 Homer St., Vancouver. $40,525.

Ont., Toronto—Maple Leaf Hockey Club, 13 King St. W., is having plans prepared for a hockey and sports arena, including artificial ice plant, etc. Estimated cost $1,250,000. Ross & McDonald, 601 Belmont St., Montreal, Que., are architects.

Equipment Wanted

Boilers and Stokers—Washington, D. C.—Bureau of Yards & Docks, Navy Dept., plans the installation of boilers, stokers, etc. $110,000.

Engine—Gridley, Calif.—City, J. L. Lewis, Clk., will receive bids until Mar. 9 for a Diesel engine to replace present inadequate steam plant standby service. Former bids rejected.

Pump and Motor — Jackson, Miss. — Mississippi Building Commission, W. C. Trotter, Secy., will receive bids until Mar. 5, for a 3 in. centrifugal pump with 25 hp. motor attached together with fittings and material required for installation.

Pumps—Dupo, Ill.—City will receive bids about Mar. 1 for two 5 in. vertical centrifugal pumps, etc., for proposed sewage treatment work. $90,376.

Pumps—Portland, Me.—Portland Water District, will receive bids until Mar. 2 for two 5 m.g.p.d. pumps with gasoline engines in connection with waterworks. Estimated cost $40,000.

Pumps—Two Harbors, Minn.—City plans to purchase 3,000,000 m.g. electric and steam driven pumps for water department.

Pumps—Wiarton, Ont.—City plans to purchase electric pumps, etc., in connection with waterworks system.

Transformers, Switches, etc. — Wellington, N. Z.—Government Railway Dept., will receive bids until Apr. 9 for transformers, armored cables, switches, static condensers, etc.

Industrial Projects

Ark., Fort Smith — Quix-Kold Corp., C. C. Beasley, Pres., Oklahoma Savings Bank Bldg., Oklahoma City, Okla., is having preliminary plans prepared for the construction of an ice plant for the manufacture of dry ice. Private plans.

Calif., Olive—Oliver Heights Citrus Association, awarded contract for the construction of a pre-cooling plant to York Ice Machinery Co., 5051 Santa Fe Ave., Los Angeles, $74,500.

Ind., Indianapolis—Eagle Machine Tool Co., 24 North Noble St., awarded contract for the construction of a factory to W. E. Van Landingham, 309 Lemcke Bldg. Estimated cost $41,000.

N. J., East Rutherford — J. T. Camlet, 26 Piaget Ave., Clifton, Archt., will receive bids about Apr. 15, for the construction of a 2 story factory at 54 Mozart St. for East Rutherford Syringe Co., 75 Mozart St., East Rutherford. Estimated cost $40,000.

N. J., Elizabeth — Allied Tar & Chemical Corp., D. W. Blaine, Pres., and Gen Mgr., South Bayway, plans to rebuild chemical plant on Richmond St. destroyed by fire. Estimated cost $40,000. Architect not selected.

N. J., Newark—Grasselli Chemical Co., Inc., 256 Liverpool Pl., is receiving bids for the construction of a 2 story addition to paint factory on Vanderpool St. Estimated cost $40,000. Private plans.

N. J., Newark—M. N. Shoemaker, 10 Bleecker St., Archt., will receive bids about April 1 for the construction of a 2 story addition to factory at 361-65 6th Ave., for Weldon Roberts Rubber Co., 18 Oliver St. Estimated cost $40,000.

O., Cleveland — General Electric Co., River Rd., Schenectady, N. Y., awarded contract for the design and construction of first unit of wire mill here, to Austin Co., 16112 Euclid Ave., Cleveland. Entire plant to consist of three units. Initial cost $1,000,000. Total estimated cost $3,000,000.

Okla., Ponca City — Continental Oil Co., awarded contract for the construction of a petroleum refinery to Alco Products Co., subsidiary of American Locomotive Co., Dunkirk, N. Y. Estimated cost to exceed $40,000.

Tex., Longview — F. Buford and E. W. Griswold, Tulsa, Okla., are having preliminary plans prepared for the construction of an oil refinery near here. Estimated cost $100,000.

Utah, Ogden — Intermountain Worsted Co., Ogden, D. Clawson, Manli, plans the construction of a 90 x 600 ft. woolen mill and 90 x 600 ft. warehouse.

Que., Valley Junction — Les Producteurs de Sucre d'Erable de Quebec, C. Vaillancourt, Secy., 5 Begin Ave., Levis, awarded contract for a 5 story, 60 x 240 ft. maple sugar refinery here to Joseph Boily, St. Georges de Beuce. Estimated cost $105,000.